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Full Steam Ahead !

The National Society of Master Patternmakers has been well and truly launched and since last April has recruited no fewer than 60 member-firms. It should be appreciated that where individual members are enrolled recruitment is facilitated, due to the fact that one firm may have several persons suitably qualified. Already, propaganda meetings have been held, which have aroused much local interest and moreover have disclosed several problems affecting member-firms. For instance, a buyer grades patterns according to his own personal notions; he also relates just what competing firms say and do. Then, it has been discovered that a wide variation in premiums are paid for the same coverage in respect of employers' liability insurance.

The obvious course to pursue in order to grade patterns rationally is for the National Society of Master Patternmakers to prepare—in conjunction with the British Standards Institution—an agreed "code of good practice." To overcome the one-sided gossip from buyers, the best method is, in emulation of Birmingham and Coventry, to form local sections of the parent Society, so that indirect gossip is replaced by direct conversation. Exchange of information on insurance rates can only result in equitable premiums being paid. Another matter which has come to light has demonstrated the advantages to be gained from "spreading the load." In these days of specialization, the output of a patternshop can be reduced by executing orders it is ill-equipped to tackle, whereas such demands may well fit into the programme of another shop. This type of collaboration has already been put into operation, with obvious advantages to the customer.

Service to the customer is the over-riding principle of the new Society, and one of its objects is to disseminate information on new techniques. We were interested to learn that the Society intends to make available to its members no fewer than 15 films on patternmaking. Whether or not they are of outstanding worth, they must form excellent subjects for discussion—which is the main factor. Only recently we saw a preview of an Italian film dealing with this subject and deem it to be of wide interest and distinct merit. We hope it will become generally available in this country. Social activities, too, are to be organized. Already, the Coventry section has enjoyed a day's outing. When, some time ago, we wrote about "filling a gap," we were convinced that such an important section of the foundry industry as the master patternmakers should—as in other countries—possess their own organization. However, we had little expectation that it would be taken up so enthusiastically and that "full steam ahead" would so soon be attained. We congratulate the pioneers on the very promising outcome of these strenuous endeavours. We believe the progress registered to be of such a character that master patternmakers can now associate themselves with the new Society with every prospect of it being of real benefit to themselves, their craft and the foundry industry.

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I.B.F. National Works Visits Day

Highly Successful Function on Tees-side

Just over one hundred attended the actual works visits organized for National Works Visits Day of the Institute of British Foundrymen by the Tees-side branch, and each "host firm" went to a great deal of trouble to ensure that the visitors had an interesting time.

For those visiting the Darlington firms, luncheon was held at the Croft Spa Hotel, with Thos. Summerson & Sons Limited, as hosts and at the White Horse Hotel with Robert Stephenson & Hawthorns Limited, as hosts, whilst visitors to Middlesbrough had luncheon at the works of Cochranes (Middlesbrough) Foundry Limited. Those visiting the Stockton and Thornaby firms, had luncheon at the Teesdale Hall of Head Wrightsons, where that firm shared the duties of hosts with Ashmore, Benson, Pease & Company and R. W. Crosthwaite & Company. In all cases, suitable acknowledgments were made to the generosity and kindness of the firms, before the parties proceeded to their afternoon visits. The transport arrangements were perfect, with Mr. J. Vickers, Mr. A. P. Riley, Mr. R. Chadwick and Mr. P. Pennington, of the Tees-side branch Council, acting as stewards.

One hundred and twenty people attended the dinner in the evening, which was again held in the Teesdale Hall of Head Wrightson & Company, Limited, and the programme set a high "tone" for such gatherings. The meal was excellent and the speeches short but good, Sir Frederick Scopes proposing the toast of "The Institute" (to which Mr. J. Bell, the president replied) and Mr. H. J. V. Williams proposing that of "The Branch" (Mr. C. H. Wilson replying). A highlight, of course, was entertainment provided by "Flotsam" (B. C. Hilliam).

There were many expressions of the excellency of the works visits and the arrangements which had been made for the convenience of the visitors. Some regret was felt that the numbers attending were smaller than usual—probably due to travelling distances—as there was no doubt that the Tees-side branch had done a first-class job of work in the arrangements.

"HOW TO MAKE IT" is the subject of the meeting on October 15 of the Tees-side branch of the Institute of British Foundrymen. The technique to make castings from identical patterns will be dealt with, for iron, by Mr. G. Taylor, for steel by Mr. A. Riley, and for non-ferrous by Mr. J. Vickers.

IT IS REGRETTED that on page 406 of last week's issue the position which Dr. L. B. Pfeil, O.B.E., holds with the Mond Nickel organization was misquoted. Actually, he is a director of the Mond Nickel Company and manager of the development and research department. He is also a director of Henry Wiggin & Company, Limited.

AT THE MOMENT of going to Press, the death is reported of MR. ROBERT FENWICK HUDSON, director and foundry manager of British Engines, Limited, of Newcastle-upon-Tyne. He will be remembered, *inter alia*, for his book "Non-Ferrous Castings" published in 1948. Details of his career will be published next week.

F.C.I. and Steel Development

The Finance Corporation for Industry, of which Lord Bruce is the chairman, expects to play as important a part in financing the steel industry's new development programmes in the future as before nationalization. In his speech at the corporation's annual meeting, Lord Bruce said that the corporation's total loans approved had now crossed the £100,000,000 mark. The actual total was £105,520,000, of which £53,000,000 was in loans to steel companies. During the past year the corporation's investments in iron and steel companies had been reduced from £39,475,000 to £36,275,000, this reduction being brought about by the repayment by one of the steel companies of its indebtedness, the company having now been returned to private ownership.

Lord Bruce intimated that, although repayment of the advances to the nationalized steel undertakings could be called for at six months from the Iron and Steel Holding and Realization Agency, he did not regard them as entirely free money. If the steel industry was to meet the national requirements, he said, it would have to continue its programme of development and modernization, and just as before nationalization F.C.I. played an important part in the financing of the development programme then in operation, so its help would undoubtedly be invoked again and any such requests would receive most careful consideration.

Conference Paper Author

E. R. EVANS, A.I.M., A.C.T.(BIRM.), Author of the Paper "Defects in Vitreous-enamelled Iron Castings," printed on page 421 of the JOURNAL, October 7, and concluded in this week's issue (page 451), joined the British Cast Iron Research Association as an apprentice in 1937. In 1942 he joined the Royal Air Force as a navigator, returning to the B.C.I.R.A. on the completion of his military service to take up an appointment on the research staff. He became an Associate of the Institution of Metallurgists in 1951, and an Associate of the College of Technology, Birmingham, the following year. He has carried out work on the fluidity of molten cast iron and is now engaged on an investigation of the problems relating to defects in vitreous-enamelled iron castings.

A CONSIGNMENT of 16 Ferguson tractors and 96 implements, including high-lift loaders, post-hole diggers, blade terracers, tippers, and trailers, has been ordered from the Massey-Harris-Ferguson group, Coventry, for the United States Army in France. A further order for 20 tractors and 145 implements has come from the U.S. Army in Western Germany.

Our Change of Address

With effect from October 25, the FOUNDRY TRADE JOURNAL and associated journals will be published from the newly-constructed office block on the site occupied nearly 30 years ago. The future address will be John Adam House, 17-19 John Adam Street, Adelphi, London, W. C. 2, telephone TRAfalgar 6171.

Layer Method for determining Teeming Speeds and Mould Orientation for making Steel Castings*

By Sten H. C. Forslund, M.E.

(*Continued from page* 411)

Pouring Conditions using Bottom Teeming and Lip Pouring

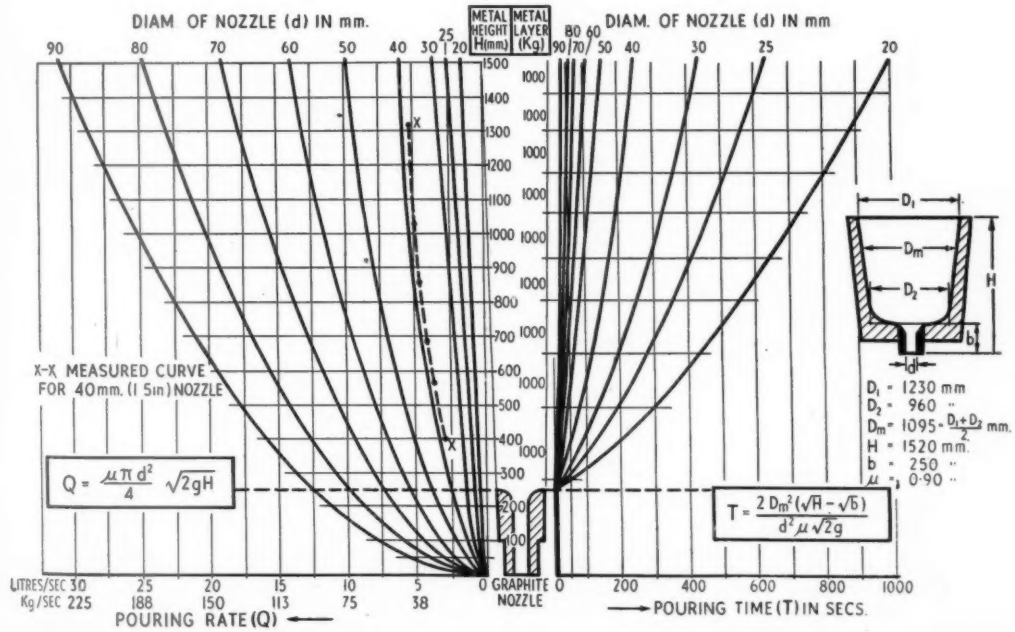
The pouring time is usually counted from the moment the metal first runs into the mould to when the mould is wholly filled with molten steel. The pouring time is primarily dependent on the quantity of metal per unit of time that leaves the ladle, and may be influenced in the second place by other pouring factors such as the fluidity (casting temperature) of the metal, the size of the ingates, the resistance to the flow, etc. In the following, an attempt is made to elucidate such pouring factors as can be modified and adapted to ensure the desired pouring times, using for the sake of simplicity molten steel as the ideal fluid.

Bottom teeming.—The pressure energy inherent in the melt at the bottom of the ladle develops into energy of motion when the nozzle is opened and the melt flows out at a rate v, which according to hydromechanics is equal to $\sqrt{2gH}$ where g represents the acceleration due to the force of gravity, 9.8 m. per sec. per sec., and H the height of the metal. As this level of the metal is lowered during the pouring, the teeming speed v diminishes parabolically.

The speed of the metal volume is next determined by the nozzle opening. An important detail in this connection is the internal form of the nozzle which has an influence on the so-called outflow coefficient μ representing the loss of energy

* Paper presented to the Florence International Foundry Congress. The Author is foundry manager, Avesta Jernverks, A.B., Sweden.

FIG. 10.—*Emptying graph for a 9-ton ladle according to nozzle diameter. Also shown are the equations used; the dimensions of the ladle, and a sketch of the graphite nozzle.*



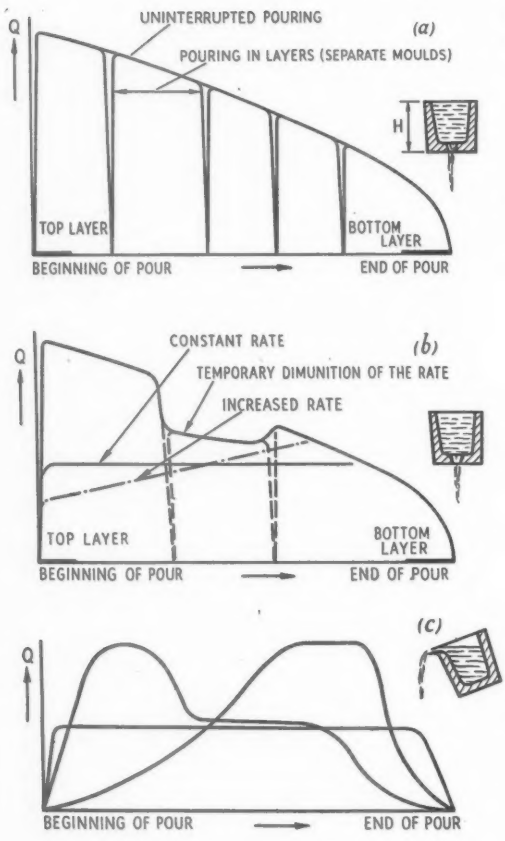


FIG. 11.—*Pouring-rate development under different conditions: (a) with quickly-opened nozzle; (b) at varying throttling of the nozzle; and (c) with over-lip pouring.*

at contraction and eddy formation in the nozzle passage. The value of the outflow coefficient for molten steel, with a graphite nozzle and well-rounded ingate edges and a conicity of 1:20, is comparatively high, approximately 0.90 to 0.95. The equation for computing the quantity of the outflowing fluid is $Q = \frac{1{,}000\ \mu\ \pi\ d^2}{4}\sqrt{2gH}$. where d represents the internal diameter of the nozzle in metres; H = height of metal in metres and Q = litres per sec.

In the left part of Fig. 10 will be found curves for the pouring rate, calculated according to this formula, through nozzles of different size with diameters from ¼ to 3½ in. inclusive for a ladle theoretically holding 9 tons of steel.

Through integration the following equation is obtained for the emptying time of a ladle, or the pouring time for a mould:

$$T_{sec.} = \left(\frac{D_2}{d}\right)^2 \cdot \frac{2tg^2\alpha}{\mu\sqrt{2g}}\left\{\left[\frac{1}{5}\left(\frac{2H}{D_2}\right)^2 + \frac{4H}{3D_2}\left(\cot\alpha - \frac{2b}{D_2}\right) + \left(\cot\alpha - \frac{2b}{D_2}\right)^2\right]\sqrt{H} - \left[\frac{1}{5}\left(\frac{2b}{D_2}\right)^2 + \frac{4b}{3D_2}\left(\cot\alpha - \frac{2b}{D_2}\right) + \left(\cot\alpha - \frac{2b}{D_2}\right)^2\right]\sqrt{b}\right\};$$

where

T stands for the total emptying time in seconds;
D_2 = internal bottom diameter of the ladle in metres;
d = internal diameter of the nozzle in metres;
α = angle of inclination of the inside mould wall;
μ = outflow of coefficient = 0.90 to 0.95;
H = height of metal in metres;
b = height of nozzle in metres.

For ladles with about 5 per cent. taper—with a conicity of 1:10, the formula may be simplified by calculating with the internal mean diameter =

$$\frac{D2 + D1}{2} = Dm$$

The formula then reads:

$$T_{sec.} = \frac{2Dm^2\ (\sqrt{H} - \sqrt{b})}{d^2\ \mu.\ \sqrt{2g}};$$

This simplified formula gives values approximately 5 per cent. too high for the total emptying time, no consideration being paid to the conicity.

In the right-hand part of the emptying graph are given estimated curves for this emptying time with different size of nozzles for the same ladle. The different metal layers and the metal height in the ladle are indicated by ordinates. What is remarkable in respect of these rates of emptying is that the last layers of melt in the ladle have a relatively low rate of flow and thus a prolonged emptying time. The graphs further show that the smaller the nozzle the less the emptying rate varies throughout the casting period; for ¾- and 1-in. nozzles it is almost constant, except for the bottom layer. The emptying time rapidly decreases with increasing size of nozzle; with 3- and 3½-in. nozzles, for instance, it is practically the same for each layer in the ladle, with the exception also in this case of the bottom layer.

The curves in this graph are thus theoretically calculated. Practical tests of the emptying rate have shown that if the μ value is selected at approximately 0.95 the curves obtained by practical tests and those established on a theoretical basis agree very well except at the beginning of the pouring where the actual rate is lower, due to the melt in the bottom layer having cooled in the interval between the tapping from the furnace and the pouring. Further measurements made, indicate that there is no enlargement of any practical importance of the graphite nozzle from erosion for this size of ladle. Nozzles made from chamotte, on the other hand, sometimes undergo such enlargement which results in a higher outflow rate than that calculated.

The normal pouring trend when bottom teeming

of a ladle into one or more moulds through a practically unrestricted ingate system and with an open nozzle is sketched in Fig. 11A. The pouring follows the same parabolic curve as in Fig. 10, the full-line curve indicating the trend when the whole of the metal is poured into a single mould, and the dotted curves pouring into several moulds, the inclination of the straight curve parts giving an exaggerated idea of the throttling of the nozzle at the beginning and end of the pouring. It is clearly apparent from this graph, as well as the two preceding ones, that the pouring rate diminishes during the whole pouring. This circumstance would seem to be one of the factors which produce the seemingly inexplicable variations of results of pouring.

In Fig. 11 (*b*) are sketched the available variation possibilities of intentional throttling of the nozzle. The horizontal line demonstrates gradual throttling of the nozzle in order to obtain a constant pouring rate. This signifies that, when applied to the ladle referred to, a 2½ in. nozzle is gradually throttled from about "1¾ in. opening" to full bore. In practice, however, this manipulation is difficult to effect. The upper curve indicates the trend with a temporary throttling which might be desirable for a certain level in a mould or at part pouring. The broken-line curve indicates the course at extreme throttling from the beginning, so that the pouring rate steadily increases during the greater part of the pouring. This is difficult to attain in practice, as the regulation is not easy to carry out and involves a considerable risk of "sticking." According to the emptying graph for the 9-ton ladle this course corresponds to a throttling of, say, a 2½ in. nozzle from ¾ in. opening and upward.

With a bottom teeming through a nozzle the pouring rate, measured in quantity of steel per unit of time, is thus normally decreasing steadily from a quickly reached maximum. The possibilities of variation are comparatively small and it is especially difficult to obtain temporary increases.

Lip-pouring is generally employed for smaller moulds and when a low pouring rate is wanted. The pouring rate is primarily dependent on the tilting and raising of the ladle. In this method the pouring rate is frequently regulated by the ingate system. The design of the ingate system is thus of greater importance in this case than for bottom teeming, where the ingate is generally dimensioned so as not to obstruct the stream of steel from the ladle.

Lip-pouring enables smoother and more flexible pouring processes a few of which are outlined in Fig. 11 (*c*). An approximately constant rate can be maintained during the whole pouring. Moreover, temporary accelerations and lowerings can be effected at any time in the course of pouring. It is easier with this method to adapt the pouring rate to the capacity of the ingate system. A certain retardation is in many cases desirable, for one thing, in order to keep back slag. On the other hand bottom teeming in principle gives a metal that is freer from slag and impurities than "lip-pouring" where the slag in the top layer has a tendency to accompany the stream of steel.

APPLICATION OF THE METHOD

From the previous sections it will be seen that the critical pouring speed is dependent upon a great number of factors and conditions and is, from a theoretical point of view, different for each section of a casting. This would seem to be one of the reasons why the pouring rate in practice is often chosen "by guess work," making it unnecessarily high in some cases and too low in others. For certain types of castings which are alike in shape but differ in size it is possible, however, to obtain suitable values of

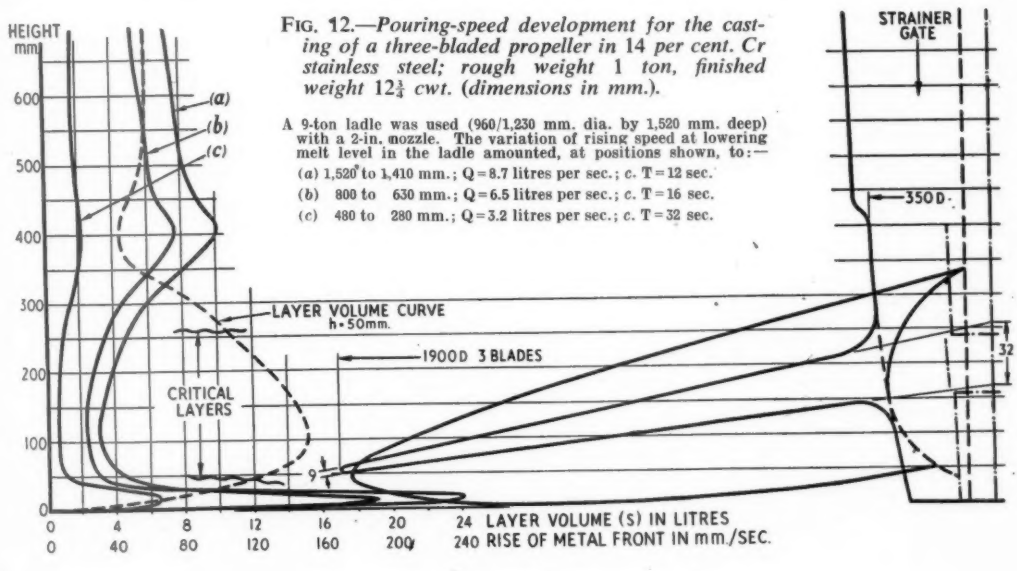


FIG. 12.—*Pouring-speed development for the casting of a three-bladed propeller in* 14 *per cent. Cr stainless steel; rough weight* 1 *ton, finished weight* 12¾ *cwt. (dimensions in mm.).*

A 9-ton ladle was used (960/1,230 mm. dia. by 1,520 mm. deep) with a 2-in. nozzle. The variation of rising speed at lowering melt level in the ladle amounted, at positions shown, to:—

(*a*) 1,520 to 1,410 mm.; Q = 8.7 litres per sec.; *c*. T = 12 sec.

(*b*) 800 to 630 mm.; Q = 6.5 litres per sec.; *c*. T = 16 sec.

(*c*) 480 to 280 mm.; Q = 3.2 litres per sec.; *c*. T = 32 sec.

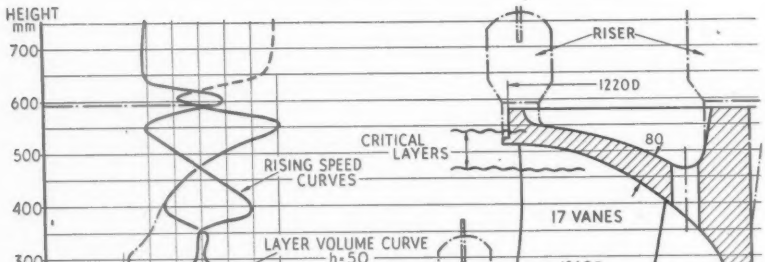


FIG. 13.—*Pouring-speed development for a Francis runner casting, with 17 vanes, using a 9-ton ladle; a 2½-in. nozzle; Q = 11 litres per sec. and T = 40 sec. (dimensions in mm.).*

the melt front rising-speed by means of statistics, which values can then be made the basis in choosing the pouring speed for other sizes of castings of similar shape. The method for calculating the rising speed and pouring rate described in the following is founded on the division of the mould in horizontal layers, and is for this reason called the layer method.

Determination of pouring rate.—The product of an empirically obtained value of the speed and the area of the actual section gives the order of magnitude of the pouring rate, computed in litres or kilograms per second. If the mould is to be filled by bottom teeming from a ladle the suitable dimension of the nozzle can be selected with the aid of an emptying graph for the ladle in question. Consideration should then be given to the height of melt in the ladle at which the mould will be filled. The approximate pouring time can also be obtained on the basis of the mould volume and the diameter of the nozzle.

Determination of rising speed.—In calculating the rising speed of the melt in different parts of the mould, proceed from a value of the pouring rate. The rising speed can then be calculated according to the equation:

$$v = \frac{h \cdot Q}{S}$$

where

v = rising speed of melt front in mm. per sec.
h = height of layer in mm.
Q = pouring speed in litres per sec.
S = layer volume in litres.

The expression for rising speed can also, with the aid of the pouring rate equation, be transformed into

$$v = 0.312_{\pi} \frac{d^2 \cdot h}{S} \cdot \sqrt{H};$$

where

v = rising speed in mm. per sec.
d = dia. of nozzle in cm.
h = mould layer height in cm.

H = average height in cm. for corresponding layer of melt in the ladle.
S = mould layer volume in litres.

The latter equation mathematically correlates rising speed in the mould with the ladle emptying rate.

Example 1.—Fig. 12 gives an example of the casting procedure for a three-blade propeller with a finished weight of 13 cwt. and a maximum diameter of 6 ft. 6 in. The propeller is cast of martensitic stainless steel from a 9-ton ladle through a 2-in. nozzle. The mould volume for the propeller was calculated in eight horizontal 2-in. deep layers and the values brought together into a layer-volume curve. This curve shows which layers demand the largest volume of metal, and in which layers the metal front has the lowest rising-speed. The variation of the rising speed was calculated at alternative pouring at a highest level of the metal, at a medium level, and from the bottom layer in the ladle.

When the propeller is poured at highest metal height, *i.e.*, from a full ladle, the pouring rate will on an average be 8.7 litres per second during about 12 seconds' pouring time. During the first few seconds the rising speed becomes high—about 240 to 260 mm. per sec. through the smaller layer volume—it is then distinctly lowered as the blades begin to absorb a larger volume. At the critical layers in the blade edges, which are susceptible to cold-shuts, the rising speed is 30 to 40 mm. per sec., subsequently rising to 70 to 90 mm. per sec. when the blades have been passed and the metal rises up into the riser.

Medium metal height gives an average pouring rate of 6.5 litres per sec. in about 16 seconds' pouring time. The rise in this case is also high in the early stages—200 to 220 mm. per sec.; in the critical layers 20 to 30 mm. per sec., and higher up 60 to 70 mm. per sec. In reality the propeller was cast at a metal height that was about level with this medium height, and did not result in cold-shuts of any consequence. A rising speed of 20 to 30 mm. per sec. would thus seem sufficient for the thin blade edges, when using this material and at the pouring temperature in question. The pouring rate for this medium height, 6.5 litres per sec. with 2-in. nozzle, according to the emptying graph for the

ladle corresponds to the rate which a 40-mm. (1½-in.) nozzle would give at pouring from the highest metal level.

The variation of the rising speed at pouring from the bottom layer in the ladle is comparatively small but the rate is also low; 60 mm. per sec. in the beginning, 8 to 10 mm. per sec. in the critical layers and about 20 mm. per sec. in the riser. This rise is no doubt too low in a case like the present one and would have produced a serious amount of cold-shuts in the blade edges. The pouring rate—averaging 3.2 litres per sec. during about 32 seconds' duration of pouring time—corresponds to only about 1-in. nozzle at pouring from the highest level in the ladle.

The propeller in this case was poured from the top through a strainer ingate, dimensioned so as to be only moderately obstructive and which permitted continuous pouring. The mould was thus filled mainly through the "building-up" of the layers and the re-fusing in the mould skin layer was most likely comparatively small. With bottom pouring with the ingates connected with, say, the bottom surface of the hub, the re-fusing will probably be greatest in the hub, somewhat smaller in the blade parts nearest the hub, and low as the blade edges are approached. In the last-mentioned regions the re-fusing is likely to be the same as with top pouring. Bottom and top pouring being thus of about equal value in respect to the risk of cold-shuts, top pouring is to be preferred on account of the feed being more effective.

If the ingates be located somewhere along the blade edges the thin sections will be filled first. As the re-fusing, furthermore, will be many times greater in these regions the pouring rate and rising speed might no doubt be reduced. In the heavier sections—the central parts of the blades and the hub—the speed can thus be lowered. This ingate system can also be utilized for a lower pouring temperature.

Example 2.—In Fig. 13 is sketched the rise during the running of a Francis wheel with a finished weight of 1 ton 12 cwt. A calculation of the different layer volumes can furnish a good guide for determining the pouring rate as well as for the location and form of the ingates. The broken-line layer curve shows that the riser on the band might lower the rising speed so as to make it critical for the thin blades. The use of the layer method in the pouring of a large number of Francis wheels has shown that the cold-shuts were to be found within the critical regions indicated by the layer curve.

Example 3.—In Fig. 14 the layer volumes are given for the casting of an inflow casing with comparatively large surfaces, weighing 11 cwt. Because of the shape of the casing it should be cast in upright position, with the largest flange upward, in order to obtain the best feeding to the comparatively thin walls.

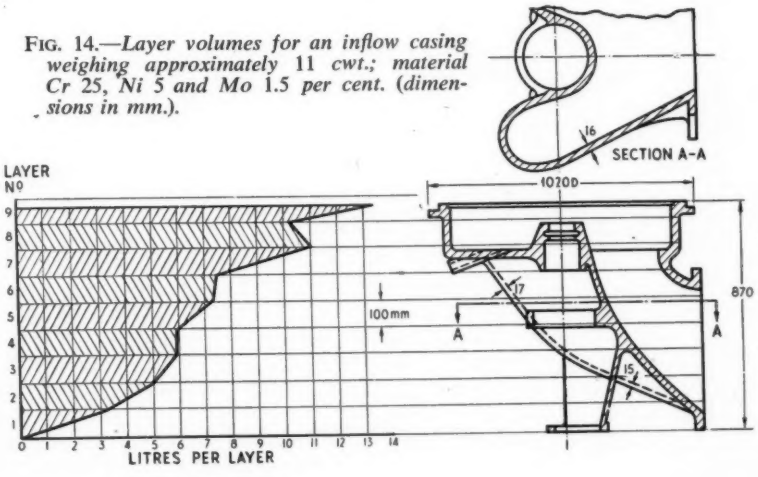
The layer volumes increase continuously from the bottom layer, the rising speed in consequence decreasing at the same rate, involving increased risk of formation of cold-shuts. This inflow casing is thus an instance where the chosen orientation position is the most favourable one from the standpoint of the feeding, whereas the reverse position, with the big flange downward in the mould, would be favourable from the point of the flowing out of the metal.

Theoretically, the pouring should take place in the upper layers in order to reduce the cold-shut risk. As any "full flow" downward into the sections cannot be attained in practice, it would probably result in rivulets or separate metal streams likely to produce a very unsightly casting skin. The best plan would seem to be to cast the casing with a rapidly rising rate of pour through ingates connected to the vertical flange.

Example 4.—In Fig. 15 are shown the layer volumes in the casting of a Pelton bucket in three different pouring positions. The demand in this case is for the production of a faultless casting-skin in the interior of the buckets of the wheel, and absolutely dense components in the part where the bucket flaps are connected with the bucket.

The upright pouring position gives the smallest layer volumes and thus the highest rising speed, affording the best prerequisites for obtaining a casting skin in the buckets free from cold-shuts, provided the ingates are connected at the lowest layers. Considering the distribution of metal in the bucket, however, and the comparatively long feeding channels in this position, it is difficult to arrange an economical riser system for feeding the part

FIG. 14.—*Layer volumes for an inflow casing weighing approximately* 11 *cwt.; material Cr* 25, *Ni* 5 *and Mo* 1.5 *per cent. (dimensions in mm.).*



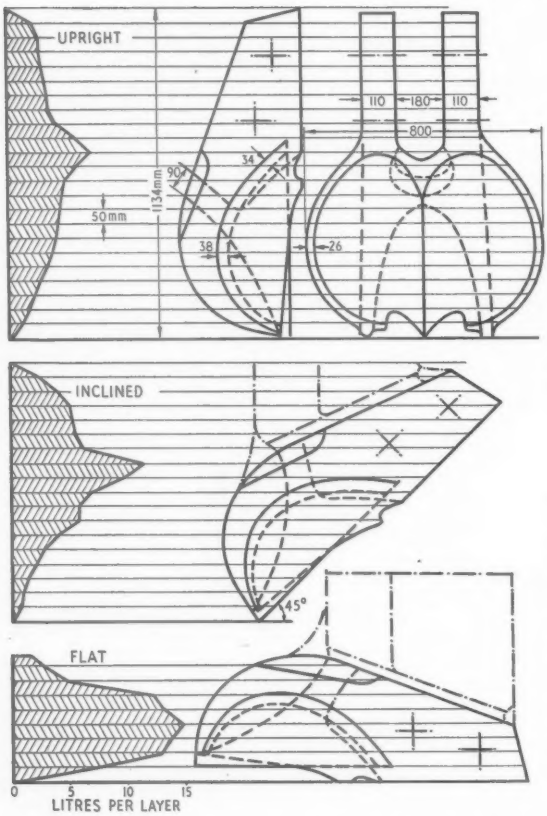


FIG. 15.—*Layer volumes for the casting of a Pelton bucket, weight* 12 *cwt., in three different pouring positions (dimensions in mm.).*

between the flaps and the wheel effectively. If the wheel were re-designed so that a directional solidification could be more easily effected for the part in question, this position would be the one preferable. An inclined pouring position gives slightly larger layer volumes for the buckets than the upright one. In this case there would seemingly be a slightly greater risk of cold-shuts. In this position it is easier to arrange the riser system, and in the figure the riser-connection of the bucket is indicated by a dotted line while the volume of the risers is not included in the layer volumes. The horizontal pouring position is comparatively favourable from the point of view of feeding, but it is theoretically unfavourable on account of the risk of cold-shuts in the buckets.

The pouring position that would seem the most favourable one for a Pelton bucket of this design is an inclined position at 30 to 35 deg. angle, which is a compromise in regard to the demands for density and a faultless casting-skin, respectively. The pouring should be rising and the ingates connected to the lowest layers.

Example 5.—In Fig. 16, the layer volume for different casting methods is calculated for a 5-in. pipe ordinary T-fitting. The volume in method (*a*) of layers 7 to 12 is very large and the risk of cold-shuts great. Casting method (*b*) gives the smallest volumes in those layers which comprise the thin sections. Methods (*c*) and (*d*) give somewhat larger layer volumes at the thin sections with increased risk of cold-shuts. The method of casting to be chosen is, however, also affected by other factors, as, for example, moulding technique, economic and other considerations. The smallest risk of cold-shuts would seem to be inherent in method (*b*) which nevertheless, involves a certain risk of these defects in the top flange.

Summary

(1) The layer method enables the regions in the mould that are critical in regard to cold-shuts, to be indicated graphically.

(2) By comparing the casting result with the calculated rising speeds for different typical castings, it is possible to obtain empirical minimum values of the rising speed for the type of steel in question. These values can then form the basis for calculating the pouring rate for similar castings.

(3) By calculating the layer volumes of the casting at different pouring positions—in cases where this position can be varied—a more solid basis is provided for determining the pouring position from both the outflow and feeding points of view.

(4) Bottom teeming through nozzle, the method for which the determination of the rising speed is mathematically conceived on account of the law-controlled emptying rate, and where the ingate system under working conditions is generally dimensioned so as to produce no restriction of the steel jet—also enables calculation of the dimensions of the different parts of the ingate system. A requisite for this is that certain values be fixed for the relation between the different sections, for example, as follow:—

Ingate area	Channel area	Sprue area	Nozzle area
1	0.6 to 0.7	0.5 to 0.6	0.4 to 0.2

After determining the pouring rate which corresponds to the rising speed and the dimension of the nozzle on the basis of an emptying diagram for the ladle, the ingate can thus be dimensioned with the aid of these relation values.

(5) When bottom teeming, the layer method can be used to plan the order of precedence in which the different moulds should be filled. The teeming speed for the different moulds is calculated, and they are set up as warranted by the decreasing rate of flow. In consideration of the diminishing rate at which the ladle is emptied, the most favourable pouring sequence will thus be obtained.

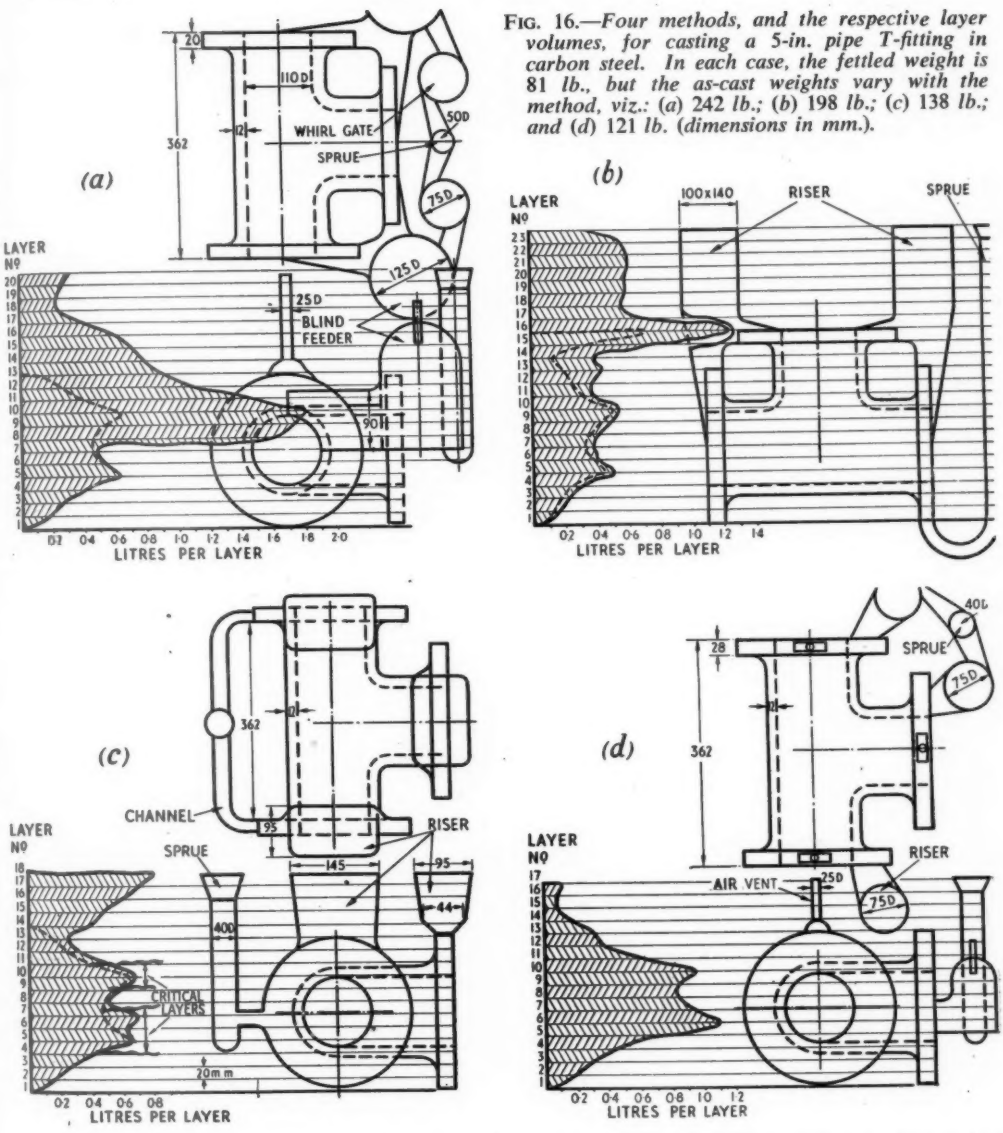


FIG. 16.—*Four methods, and the respective layer volumes, for casting a 5-in. pipe T-fitting in carbon steel. In each case, the fettled weight is 81 lb., but the as-cast weights vary with the method, viz.: (a) 242 lb.; (b) 198 lb.; (c) 138 lb.; and (d) 121 lb. (dimensions in mm.).*

(6) For bottom teeming which does not allow the ladle emptying speed to be conveniently varied during the pouring, the pouring rate is determined with consideration to a single critical mould layer only. In lip-pouring, the emptying can be varied more conveniently, and there are consequently greater facilities for adapting the pouring rate in relation to the layer-volume curve. Consideration can thus be given to the rising-speed demands for the different layers.

JOSEPH BATSON & COMPANY, LIMITED, Tiptone Works, Tipton, Staffs, announce that Mr. W. E. J. Cross, formerly development engineer and sales manager, has recently been appointed general manager of Joseph Batson & Company, Limited, Tipton, Staffs.

F. H. LLOYD AND COMPANY, LIMITED, recently organized an "open day." During the proceedings, employees, families and friends at the James Bridge Steel Works, Wednesbury, witnessed the pouring of a 12-ton steel casting.

Ninth I.B.F. Golf Meeting

The ninth meeting of the Institute of British Foundrymen Golfing Society proved a most eventful weekend over Saturday and Sunday, October 2 and 3. Once again the Golf Hotel at Woodhall Spa produced everything one could wish for at the "19th," and the golf course was in immaculate condition, to which justice was done by some very good scoring.

Results

Saturday morning:—Stroke Competition for the I.B.F. handicap and scratch cups (34 competitors).

1. A. T. Johnston ..	89−22=67	Winner handicap cup.
2. P. B. Higgins ..	76− 8=68	Winner scratch cup.
3. R. C. Shepherd ..	89−15=74	Second handicap prize.
4. H. L. Thorne ..	87−13=74	Third handicap prize.
5. R. T. Turner ..	88−13=75	..
6. W. Embley ..	84− 9=75	
7. L. Mortlock ..	84− 9=75	
8. W. Jones ..	90−15=75	
13. H. C. Hanson ..	97−19=78	Winner veterans' cup.

In addition to holding the handicap and scratch cups for one year, the winners also received a tankard each, kindly presented by Mr. E. Longden, immediate past-president of the Institute. The veterans' cup (challenge) winner also received a tankard presented by Mr. W. E. Aske, donor of the trophy. The second and third handicap prizes were presented by Mr. R. B. Templeton. The branch "Coronation" challenge shield was won by the N. R. Yorks 1st team—P. B. Higgins 68, H. Oliver 78 and W. Jones 75 = 221. The winners also received prizes presented by last-year's winners.

Saturday afternoon:—Greensome foursomes *v* bogey.

1. W. Embley and J. Bell ..	(11)	4 up.
2. L. Mortlock and H. Shaw ..	(12)	4 up.
3. R. C. Shepherd and A. Swain ..	(12)	2 up.
4. E. A. Phillips and H. C. Hanson	(11)	All square.
5. R. S. Smeeth and W. Jones ..	(9)	All square.

The winners received a chromium-plated Lincoln imp each, kindly presented by the Lincolnshire branch.

Sunday morning:—Four-ball foursomes *v* bogey.

1. W. H. Cook (24) and J. T. Peck (18)	7 up.
2. H. Shaw (23) and F. Webster (21)	7 up.
3. R. T. Turner (13) and W. E. Aske (21) ..	6 up.
4. P. G. Pennington (9) and C. H. Wilson (20) ..	5 up.
5. P. B. Higgins (8) and G. W. Nicholls (14) ..	5 up.

The winners received ½-dozen golf balls each, kindly presented by Mr. R. S. Darby.

Ladies Competition (*Stapleford*)—This was held on Saturday morning when nine competed for the ladies Coronation rose bowl (challenge).

1. Mrs. W. N. Cook	(9)	30 points.
2. Mrs. W. E. Aske	(29)	24 points.
3. Mrs. E. W. Pugh	(29)	24 points.

The runner-up received golf balls presented by Mr. R. B. Templeton.

Annual General Meeting

At the Annual meeting of the I.B.F. Golfing Society, the president, Mr. R. B. Templeton, in the chair, presented the prizes. Afterwards, the following officers for next season were elected or confirmed in office:—As *president:* Mr. E. A. Phillips; *vice-presidents:* Mr. V. C. Faulkner; Mr. R. C. Shepherd; and Mr. R. B. Templeton; *committee:* Mr. J. Bell; Mr. G. W. Nicholls; Mr. I. A. Menzies; Mr. F. Arnold Wilson; Mr. C. H. Wilson; and Mr. P. G. Pennington (hon. secretary).

(*Continued at foot of col.* 2)

Centenary of Robey & Company

The engineering firm of Robey & Company, Limited, was founded in 1854 by Robert Robey, a young man who had served his apprenticeship in Lincoln. He entered into a partnership with two or three local gentlemen to manufacture steam engines, boilers and thrashing machines. Their earliest recorded production was a portable steam engine exhibited at the Royal Agricultural Show in 1854, which was held on the site which now forms part of the 14 acres occupied by the present works. On the passing of the 1862 Companies Act, the partnership was dissolved in favour of a limited liability company which continued until 1874. The company then reverted to a partnership with Thomas Bell (the father of the present chairman and managing director) and John Richardson, as managing partners until 1893, when it was converted to the present limited liability company.

Current Activities

Considerable extensions and alterations have been made during the last 100 years, both as regards the works and their manufactures. Whereas at the start the products were solely of an agricultural nature, this trend very soon gave way to a much wider industrial range, and the history shows that Robeys were among the pioneers in many developments. The company at the present time is busily engaged in the manufacture of electric winders for coal and metalliferous mining. These winders are now installed in every part of the world where mining is carried on, and they have been developed to incorporate many modern improvements including the Robey-Crompton positive power brake. Within the scope of the factory, which includes pattern-making, foundries, welding, etc., in addition to normal machining, erection and testing facilities, any type of heavy engineering can be, and frequently is, undertaken. In other words, Robey facilities are not tied rigidly to a set range of goods, and these, allied with the engineering skill fostered and maintained during the past century, have gained the company an established position as the "complete" engineers.

Robey & Company have marked the year by payment of a centenary bonus to all employees with one year's service or more. They celebrated the event by a works outing to London on September 25, a special train having been chartered for the occasion, and a very interesting programme arranged, culminating in a mass visit to the Hippodrome Theatre.

Mr. R. B. Templeton's resignation from the presidency was accepted with much regret; in his several years of office he has done much to raise this annual event to such a great success. The members were unanimous in support of Mr. E. A. Phillips, the new president.

Carrying out his last official duty as president, Mr. Templeton recalled in glowing terms the work which Mr. F. Arnold Wilson had done in firmly establishing the Golfing Society during his long period as hon. secretary. On behalf of all members he had great pleasure in presenting to Mr. Wilson an inscribed cigarette case as a token of their thanks for his great service. Mr. Wilson also received a box of chocolates for his wife with the good wishes of the Society.

Next year's meeting is to be held at Woodhall Spa on September 24 and 25.

Tame Bridge Foundry of W. & T. Avery, Limited

Just completed is the building of a new grey-iron foundry at Tame Bridge, near Walsall, for W. & T. Avery, Limited. The firm already have a modern light mechanized foundry at Sherburn-in-Elmet, in Yorkshire, but the new foundry has been designed and equipped to make heavier castings and to include the transfer of production from the firm's very old foundry at Soho, near Birmingham. At the present time, only about one-quarter of that production has been taken over, so the new foundry is working at much less than half its capacity and some sections are not working at all. What follows is a brief account of the plant and layout. It is hoped it may be possible to record further details as production at the foundry is developed.

For sound reasons, the foundry trades have, in their long existence, acquired a reputation for being included among the " dirty " industries where atmospheric pollution in a fume-laden workshop, often made arduous and unpleasant working conditions. Now, for equally sound reasons, that reputation is refuted. The new £1,250,000 foundry at Tame Bridge, near Walsall, which W. & T. Avery, Limited, have built, incorporating all the most up-to-date and efficient equipment and techniques to be found, it is claimed, in the world, conclusively proves that the foundry can have a clean, healthy and even pleasant environment. The modern techniques exemplified there show, too, that the ironfoundry trade is neither one demanding heavy manual labour, nor one needing " hard work " which has previously been thought to be the foundry craftsman's lot. The new Avery foundry is a remarkable testimony to the research that has gone forward in recent years on foundry practice, and a tribute to the company's vision in building the new premises.

Raison d'Etre

The Tame Bridge foundry, as yet only in part production, is to replace the foundry at the Soho works, Smethwick, although all the firm's other activities in the engineering field will be continued there. Work on the new foundry began in 1951, the decision to build having been taken because the facilities for expansion at Smethwick had been exhausted, and it

FIG. 1.—*Small sand plant at Avery's new Tame Bridge foundry.*

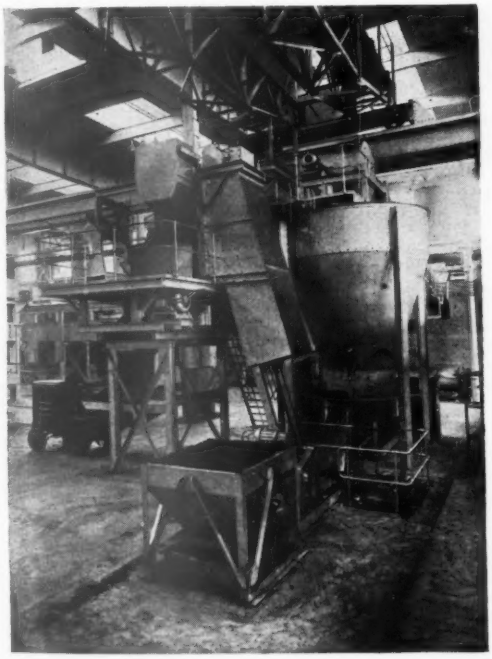


FIG. 2.—*Sand plant serving the heavier types of moulding.*

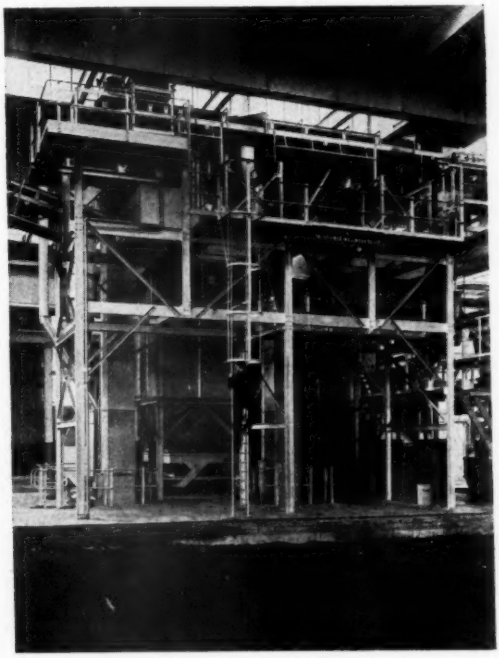
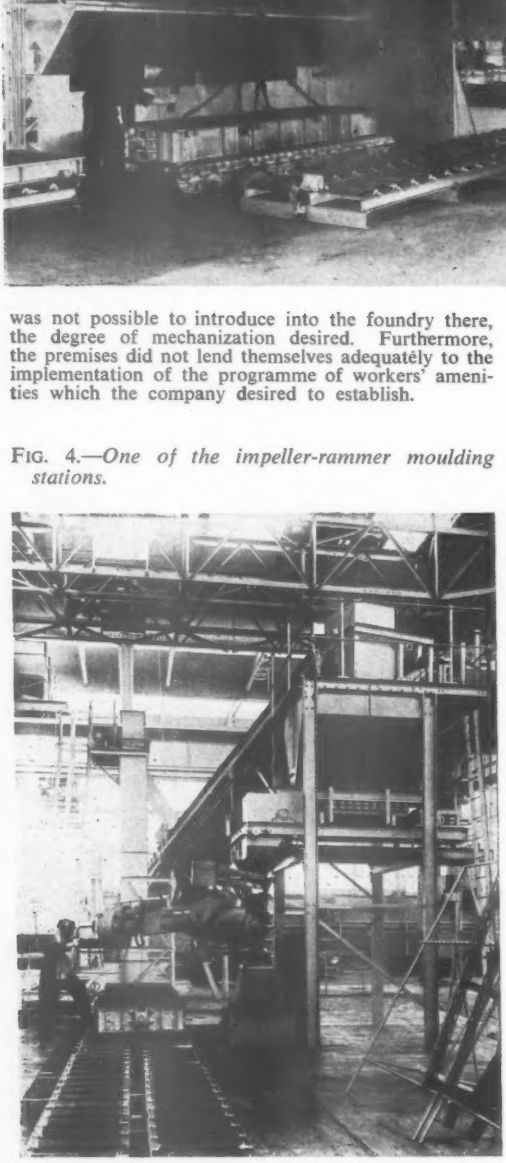


FIG. 3.—*Knock-out for medium-size castings, served by telpher crane.*

was not possible to introduce into the foundry there, the degree of mechanization desired. Furthermore, the premises did not lend themselves adequately to the implementation of the programme of workers' amenities which the company desired to establish.

FIG. 4.—*One of the impeller-rammer moulding stations.*



The 122-acre site at Tame Bridge offered opportunity for all developments planned by Averys. In designing the new foundry it was laid down that "this foundry was to be a commercial success; it was to serve at a national model of efficiency." Deliberately flexible in layout, the foundry is designed so that it can be swiftly adapted to meet changing needs without dislocation to the production flow.

There is, as one would expect, a high degree of mechanization. Almost every job is mechanically assisted and world resources have been explored to acquire the machines and equipment. Whilst most is of British make, some of it comes from America and some has been designed by Avery engineers. Stress is laid, however, on the fact that there is no elimination of the foundryman's traditional crafts and skills. The trained ironfounder still has full scope for his skill.

Amenities

For that reason, and because of the basic acceptance of the part played by the individual in foundrywork, Averys have established a very high standard of working conditions and amenities at the Tame Bridge foundry. Space, light, good ventilation and a strikingly fine colour-scheme, characterize this large foundry, and the problem of dust and fume control has been given priority, the methods used incorporating the most modern results of research and experiment on this matter which has previously been the cause of a certain amount of prejudice against the foundry industry. Adjoining the workshops is a large amenities block, almost textbook in its provisions of up-to-date facilities and welfare, including heated, separate lockers, shower-baths, and a clinically commendable cloakroom environment. A canteen, agreeably coloured in grey and orange, and a first-aid station supplement the welfare provisions. All corridors and offices have an unusually attractive colour scheme of grey and strawberry. Pastel shades dominate throughout the building, giving an effect of light and cheerfulness.

Among the noteworthy equipment is the motive "Speedslinger," reputed to be the third in Great Britain at present. Carrying its own sand supply in detachable hoppers, each holding 15 tons, it delivers sand to the moulding boxes at the rate of 2,000 lb. per min. Controlled by one operator, the machine does in a few minutes the equivalent of many hours of hand ramming. Working in conjunction with the "Speedslinger" is a heavy sand plant which recovers used sand and prepares it for further use. The sand is shaken free over a rectangular grille, claimed to be the largest "shake out" in Europe. The prepared sand is fed back into the 15-ton hoppers.

Another of the major improvements introduced at Tame Bridge is the continuous-flow cupola furnace of which two have been installed, each being used on alternate days. They melt at the rate of 9 tons an hour. The ingredients of the charge pass through a

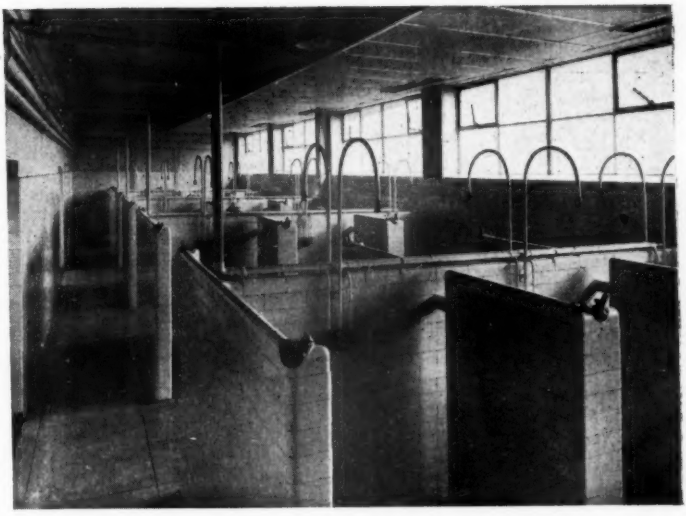


FIG. 5.—*Shower-bath accommodation in the amenities block at Tame Bridge.*

weigh hopper into a drop bottom bucket which is carried to the furnace by a charger of new design. The melted metal is stored in an oil-fired receiver. The cupolas incorporate dust arresters which wash the effluent gases, using 142 gallons of water a minute.

A further interesting technique is the pattern flow system for the production of medium-size castings in quantity. They are rammed up in the moulding boxes by an impeller rammer delivering about 800 lb. of sand per min. The method has only recently been applied to castings of this size and is the result of a successful experiment made at the Soho foundry some five years ago. The flow scheme has its own shake-out and sand-reconditioning plant.

Scope

Production at the Tame Bridge foundry will cover all heavy castings, and those lighter castings not required in substantial quantities—the firm's foundry at Sherburn-in-Elmet, acquired in 1946, is to continue to deal with smaller repetitive work. Ultimately it is expected that approximately 300 operatives will be employed at the Tame Bridge foundry; the transfer of personnel from Soho is taking place gradually. The company hopes eventually to be able to produce 50 tons of castings for each of its workers every year. That figure is higher than the American average.

Modern Silver Exhibition

Some of the most distinguished contemporary pieces of silver are included in the Exhibition of Modern Silver at the Birmingham Museum and Art Gallery which opened on October 8 and closes on November 15, organized by the Worshipful Company of Goldsmiths in collaboration with the Birmingham City Museum and Art Gallery.

The extent to which industry and civic patronage is replacing the traditional individual patron is exemplified by the exhibition. Courtaulds (Alabama), Limited, the new American subsidiary of the firm, has lent for display the silver rose bowl presented by the parent company. The Athenaeum Club, London, has lent the bowl made by Leslie G. Durbin for the club to commemorate the Coronation of Queen Elizabeth. Other silver pieces associated with the Coronation include the Queen's Cup commissioned by the Worshipful Company of Goldsmiths to the design of Professor R. Y. Goodden, and the Coronation Bowl commissioned by the Birmingham Museum and Art Gallery Committee and designed by Mr. Cyril J. Shiner.

Examples of civic patronage include the Solihull Cup presented by Birmingham on the occasion of the granting of a Charter of Incorporation to Solihull and the Coventry Cup presented by Birmingham to Coventry when a Lord Mayoralty was conferred on that city. Outstanding in historic interest among the exhibits, most of which have never previously been publicly displayed, is the pen of gold, silver and enamels with which the Queen signed the Coronation Oath in Westminster Abbey. The pen has been lent by Her Majesty to whom it was presented in 1953 by the Worshipful Company of Scriveners.

Electricity for Industrial Heating

Mr. J. I. Bernard, M.I.E.E., M.I.H.V.E., chief technical officer of the British Electrical Development Association, in the course of a paper, "Developments in the Industrial Uses of Electricity" which he submitted to the annual conference of the National Smoke Abatement Society at Scarborough, said that many examples might be given of the diverse processes using electricity, ranging from the production of special steels and alloys which could only be made (because of their composition or precise heat treatment) in an electric furnace, to a small induction-heater operated by unskilled labour for the case hardening, according to an automatic time cycle, of injection pump p'ungers which had to be held to very close tolerances in their dimensions and hardness. He pointed out that in addition to the savings in capital and running costs electric steel melting saved fuel since each ton of steel produced in an arc furnace required approximately 550 lb. of low-quality coal to be burned at the power station, whereas each ton of steel produced in the open-hearth furnace needed the best part of 700 lb. of high grade, low-ash, coal to be burned in the producer-gas plant.

Mr. Bernard said there were also advantages from an operating point of view; an arc-furnace was much more flexible, it could be readily shut down and re-started, it could run on a small charge or a single shift. Furthermore the improved working conditions should be mentioned, the operator always had close control of the process, there was plenty of scope for him to use his intelligence and produce a good melt. In regard to induction heating Mr. Bernard said that the main advantage was the speed of heating, for example a 1¼-in. billet needed only 45 seconds, compared with 10 minutes in an ordinary furnace.

Notes from the Branches

Bristol and West of England

The Bristol and West of England branch of the Institute of British Foundrymen commenced its winter session earlier than usual, with a visit to the works of Fullers' Earth Union, Limited, near Bath, on September 4. The party was conducted round the plant and mine by the works manager, Mr. T. W. Holmes, who gave a very clear and illuminating talk on the occurrence of Fullers' earth, and indicated its many applications, not only in foundry, but also medical and general engineering spheres. Members were greatly interested to learn that considerable quantities of Fullers' earth are used in the coal-mining industry. The various processing plants, crushing, drying and loading sections were inspected, and a visit was paid to the laboratory where members saw routine tests being carried out on samples—it being explained that for certain uses the alkalinity of the product must be maintained within close limits.

Members then visited the mine from which the "earth" is obtained by digging, the comparatively soft nature of the material preventing its being removed mechanically as in the case of coal mining. The seams of true rock and workable "earth" were clearly visible at one of the working faces visited, and many members, for whom this represented a first visit to mine workings, were greatly impressed by the heavy loads sustained by the wooden pit props. The party was subsequently entertained to tea by Mr. Holmes, who was thanked for the hospitality extended to the branch by Mr. H. V. Heath, the branch president.

Technical Meeting

The opening technical meeting took place at the Grand Hotel, Bristol, on September 25, when Mr. E. C. Ellwood presented a Paper on "The Continuous Casting of Bronze," the talk being illustrated by a film and slides. Prior to the lecture, Mr. H. V. Heath, the new branch president, delivered his address, Mr. D. P. Williams, junior vice-president, being in the chair.

Mr. Heath pleaded for a better understanding between the foundryman and the engineer, saying that as an engineer dealing with foundry products, he considered there was much that the foundryman could do to improve the quality of castings delivered to the average customer. Whilst agreeing that good design was the key to the successful production of castings, experience suggested that many inferior castings were produced which a little extra care and forethought could prevent. Whilst the foundryman could often explain the reason for defective castings he often appeared loath to take the action necessary to prevent a recurrence of the trouble.

Illustrating this point, Mr. Heath said that carelessness in the foundry could lead to damaged patterns with consequent loss of dimensional accuracy, apart from the heavy cost of pattern repairs or even replacements. Again, lack of care in coring operations could often scrap a valuable casting or make expensive rectification operation necessary. A further point was that castings produced in unsuitable or incorrectly-alloyed materials could cause much damage to costly machine-tools.

Each of these items might be the responsibility of particular sections of the founding industry, but it was felt that all concerned could and should endeavour to try and overcome such faults which arise in everyday foundry practice. As Mr. Heath asked in his final remarks: "What can be done about it?"

Mr. E. C. Ellwood, in presenting his Paper on the "Continuous Casting of Bronze," outlined the principles on which the process is based, and illustrated by means of a film and slides the comparatively simple apparatus by which the process is operated and the type of rod or tube which can be produced. Some actual samples of both rod and tube were exhibited for the benefit of members.

Although still in the development stage, the process has been successfully applied to the casting of many copper-base alloys, a noteworthy feature being the dimensional accuracy which can be obtained even with lengths of up to 12 ft. Whilst the process has been mainly developed for use with copper alloys, there are indications that it can be adapted for most materials, including steel.

Replying to questions, Mr. Ellwood stated that although the existing method was vertical in operation, there was the possibility that an inclined plane method could be used, but at the present moment no information was available on this point. Much work had still to be done on the question of casting speeds for various alloys, whilst much attention had to be paid to the actual casting temperatures employed.

Mr. Ellwood was thanked by Mr. D. P. Williams, who said that he was certain that all members had learned much from the Paper, the vote of thanks being seconded by Mr. H. Balme.

Australia (Victoria)

On August 18 a joint meeting was held between the Australia (Victoria) branch of the Institute of British Foundrymen and the Australian Institute of Metals. The lecturer was Dr. F. A. Fox, chief superintendent of the Chemical and Physical Research at the Salisbury laboratories of the Department of Supplies. His subject was "The Casting of Magnesium and its Alloys." The lecturer discussed the metallurgical factors influencing casting behaviour and correlated these with foundry techniques. The problems of grain refinement, heat-treatment and inspection were dealt with and information was given about the new zirconium-containing alloys. The chair was taken by the president, Mr. J. D. Ebeling.

South Africa

Members of the South African branch of the Institute were recently the guests of the S. A. Pulp and Paper Industries for a works visit.

Two films were shown at a recent meeting of the Metallurgical sub-section of the branch. One was the well known "Flow of Metals into Moulds" and the second—introduced by Mr. A. G. L. Lewis—"The Story of Meehanite."

The May meeting heard a lecture, "Heat-treatment of Carbon-steel Castings" by Mr. R. Ballantyne, of the Dunswart Iron and Steel Works. Mr. H. J. G. Goyns presided. The lecturer's remarks covered the cooling of the steel from the molten state; fuels, furnaces and furnace atmospheres, and details of the process of heat-treatment. The Paper was profusely illustrated with photomicrographs and diagrams. Dr. Bereza made a noteworthy contribution to the discussion by the introduction of S curves. The Author was thanked on behalf of the party members present, by Mr. Jane.

London—East Anglian Section

On September 22, by kind permission of the directors, the section took part in a works visit to the

Suffolk Iron Foundry (1920), Limited. The 25 members were welcomed by Mr. F. Tibbenham, director, and his colleagues, and were conducted on an extensive tour of the foundry, shell-moulding department, fettling shop, tinning and vitreous-enamelling departments, and the main shop where the various components of the company's products are assembled.

No restriction was placed on any department, and the visitors had the opportunity of seeing some of the company's very fine products, particularly in the shell-moulding department, which it was learned was in its infancy but a high rate of production was being obtained. The foundry and fettling-shop layouts were considered to be excellent in their general layout and tidiness, the range of castings and fine finish being the subject of much admiration. At the end of the visit the section was entertained to tea by the company.

Mr. C. N. Jennings, the section president, proposing a vote of thanks to the company and Mr. Tibbenham for receiving the section, said that he had known the Suffolk Iron Foundry for a good number of years and every time he revisited the works he found that there was some extension to the company's activities. He was also amazed at the rate of productivity in the foundry and other departments which, he thought, compared more than favourably with the productivity he had recently seen in some American foundries. He hoped that the company would continue to expand its products, which were mainly for the export market, and would, at some time or other, invite the section to revisit.

Mr. F. Tibbenham, replying, said that he was always pleased to have the Institute of British Foundrymen visiting the works and particularly the East Anglian section, of which his father, Mr. L. Tibbenham, was a founder member, and he hoped that the visit had been profitable as well as enjoyable.

Another Scrap Price Offence

To maintain business and to prevent 150 workers from becoming unemployed, a Birmingham steel firm, with a foundry at Tipton, infringed the Iron and Steel Orders, it was stated at Birmingham Quarter Sessions on Tuesday, September 28.

The firm, the Birmingham Steel Company, with offices in Palmer Street, admitted having purchased cast-iron scrap for more than the maximum price permitted. The firm was fined £5 on each of eight counts and ordered to pay £25 costs; 43 other offences were taken into consideration. Defending, Mr. A. E. James said that because of a shortage of scrap in the area the firm had been working from " hand to mouth." It was authorized to hold four to five weeks' supplies, he said. As it was entitled to do the firm had bought scrap from the South of England, where supplies were more plentiful, and by paying more for the material the foundry had been saved from closing down, although the firm had suffered financially to the extent of nearly £3,000. No extra cost had been passed on to purchasers of the firm's products, added Mr. James.

Prosecuting, Mr. R. K. Brown said that the total amount involved in the charges and other offences taken into consideration was £550, while " an overall picture " showed an amount of £2,923. The Assistant Recorder, Mr. S. L. Elbourne, said that it was not suggested that the firm had made any profit from the transaction, nor that it had bought quantities in excess of those permitted. The firm had, however, paid 20 per cent. above the permitted price. " This firm had been struggling to keep itself going and prevent a lot of people getting out of work if they did not obtain the material," said Mr. Elbourne.

New Catalogues

Welding Zinc-base Die-castings. Suffolk Iron Foundry (1920) Limited, Stowmarket, Suffolk, have just issued a practical handbook on this subject which gives a really good description of the actual operation of the job. This, apparently, is necessary, because the process demands considerable skill. The handbook is available to those readers who write to Stowmarket.

Cerium (Mischmetall). An eight-page pamphlet received from British Flint and Cerium Manufacturers Limited, 8, Spring Gardens, Trafalgar Square, London, S.W.1, details the properties of cerium metal and outlines the composition of Mischmetall. The balance is made up of references to uses as reported in the world's technical Press. The application to nodular cast iron is stressed.

Dust Control Equipment. Dallow Lambert & Company Limited, of Spalding Street, Leicester, have recently issued a folder containing brochure D.C.E. 34 and leaflets numbered 27, 28, 29 and 31 and folder No. 37. The brochure is a collection of illustrations of jobs they have installed, amongst which are quite a few foundry installations. The leaflets show by outline drawings the underlying principles of the control units they manufacture. This publicity matter reaches a high standard: good use has been made of colour printing and is well written. They are available to readers on writing to the Leicester address given above.

Magnetic Sorting and Radiography Source Containers. Solus-Scholl, Limited, 18-22 New Cavendish Street, London, W.1, have prepared a four-page leaflet which describes and illustrates an instrument for sorting out large quantities of small ferro-magnetic components. The instrument sorts specimens according to heat-treatment (structure, hardness and strength) and alloy composition. It can, of course, also be used for separating magnetic from non-magnetic parts. The rate of testing varies from 1,000 to 7,000 pieces per hour, according to size. A second leaflet announces the availability of storage and exposure containers for Cobalt-60 sources up to 10 curies as used in industrial radiography.

Hopper-filling Plough.—The Baillot Products Company, Limited, 11, Rock Lane, Linslade, Leighton Buzzard, Beds., have recently issued a leaflet, emanating from a Detroit concern, which describes and illustrates the Proto Plow. The rights for the manufacture of this speciality having been acquired by the Leighton Buzzard Company. The arrangement adapted to the filling of moulding-machine hoppers is interesting as it is automatic but requires no power, gravity being the only force utilized in the operation. The system is based on the movement of levers, and the contrivance is such that as the hopper fills, the sand supply from the belt is shut off, through the movement of a hinged vane mounted in the hopper. This vane is counterbalanced by the weight of the plough. The equipment is adjustable to give a supply co-ordinated with the flask size being used. Should the box size be altered, the plough is adjusted. With the arrangement goes a signalling system to the sand-preparing mills so that the output of that plant can be regulated according to the consumer plan. This interesting pamphlet is available to readers on applying to Leighton Buzzard.

New Equipment

Hydrostatic Dust Collector

A new type of dust collector has been added to the range manufactured by Dallow Lambert & Company, Limited, Spalding Street, Leicester.

Previously available in the MSE series and applied in the main as an individual unit for fettling booths, double-end polishers and grinders, the new series ME is available to handle large volumes of air and heavy dust-concentrations. This new series, employing a patented hydrostatic cross-tube element, scrubs dust-laden air in either water or oil.

Of modern, streamlined design, the unit attains a high separation efficiency; it is very compact; bears a high air volume to cost and space ratio, and operates without either pumps or sprays. It is eminently suitable for foundrywork, sanding operations, etc.

FIG. 1.—*Hydrostatic dust-collector showing hand-controlled valve for sludge removal.*

The illustration shows model ME 10/9 designed as a complete unit to handle 1,000 c.f.m. A hand-controlled valve allows for sludge removal on this model. These collectors are manufactured in sizes ranging from 200 to 100,000 c.f.m., the larger ones being fitted with multiple cross tube elements and automatic sludge disposal. In the case of soluble dusts where no sludge is formed it is usual to arrange for drainage, continuous or intermittent, either to waste or to a reclamation process, according to the value of the dust.

JAS. C. CUNLIFFE, LIMITED, general patternmakers, have transferred to new premises at 46, Church Street, Pendleton, Manchester. Telephone: Pendleton 2138.

Film Reviews

One-off or a Million. Produced by the Big Six Film Unit for Lloyds (Burton), Limited.

This film, which lasts about 40 mins., illustrates the processes used, the welfare arrangements established, and the application of the company's productions. The film emphasizes the wide range of materials and includes Austenitic manganese steel, spheroidal-graphite cast iron and shell-moulded castings. The object of the film is to increase the firm's sales, at home and overseas, and in the latter connection a series of foreign language versions are available. The reviewer was pleased to note that during the taking of the film at the Wellington Works, Burton-on-Trent, no smoking was allowed. This is important for overseas exhibitions, as not all countries permit smoking in industrial workshops. Being a publicity rather than a documentary film, the viewer is rightly not allowed to forget to associate the name of Lloyd with quality production.

"Engineers in Steel." Produced by the English Steel Corporation's own photographic unit.

This is a beautifully-coloured film lasting for fifty minutes. It is difficult to decide whether it is a documentary or a sales effort. It certainly emphasizes the great size of the undertaking and the firm's ability to manufacture forgings and castings, which weight alone restricts the source of supply to very few firms throughout the world. The picture starts with shots of Sheffield's countryside, the beauty of which is a natural phenomenon and can also be associated with the other traditional areas of steelmaking such as St. Etienne in France or Essen in Germany. Where nature provides water-power, millstone grit and gannister, the sites were originally and sometimes still are—beautiful. The pictures of the old works are full of interest, for it was there that craftsmanship was cradled. A shot which appealed to the reviewer as an old steel maker was one showing the "boiling down" of a charge. It achieved near-perfection. In the later sequences the mechanization of some of the processes was of a particularly high order, whilst a very short version (for which a separate film is available) of the casting of an outsize steel casting for a forging press, stressed craftsmanship at its best. Five foreign language versions are being made and that in French is due for its first showing in Zurich this week. It is a delightful film that well merits exhibition before the various technical societies of this country.

Future of Titanium

Speaking at a meeting of the Midland Metallurgical Societies in Birmingham on September 27, Dr. W. J. Kroll said that enormous capital has been invested in the development and production of titanium in the United States. One estimate was that 250,000,000 dollars were backing the new industry.

Dr. Kroll, who pioneered the production of the metal from its ores, said that titanium had many very good properties, and would probably be extensively used in jet engines and other parts of aircraft. If its price could be reduced, it would probably be used in the home. Dr. Kroll added that there was no need to worry about the present high cost. He felt that cheaper methods of producing the metal would be found. One United States concern was planning production of 10,000 tons a year. In Great Britain, I.C.I., Limited, had laid down an expensive plant for titanium production, he said.

Defects in Vitreous-enamelled Iron Castings*

By E. R. Evans, A.I.M., A.C.T. (Birm.)

(*Continued from page* 425)

Defects from Other Causes

The points under the previous headings have dealt with the more obvious defects, most of which can be traced to some irregularity in foundry and enamel-shop practice. There still remains, however, the serious problem of blistering to be considered, since this defect often has no apparent cause. If a blistered enamel is shot-blasted from a casting, in many cases there is no visible blemish on the cleaned surface and re-processing may produce a blister-free result or blistering may occur again. Blisters are caused by an evolution of gases from the region of the iron/enamel interface, and it is the possible sources of these gases that will be discussed in this section. Pinholing, boiling, and black-specking are merely developments of blistering as illustrated diagrammatically in Fig. 3, so that in general these defects will all be implied when blistering is referred to.

Sub-surface Defects:

Although the surface of a casting after cleaning may appear sound, beneath the surface there may be defects which will cause the applied enamel to blister. These defects can only be detected by sectioning the casting and, even then, in some cases micro-examination of the section is necessary. Blowholes which may or may not have a small opening to the surface can be troublesome, although often they are detected when re-blasting "opens them up." The gas entrapped in a sub-surface blowhole will diffuse through the thin layer of metal at the surface and cause blisters in the enamel, while such a blowhole with a small opening to the surface cannot be adequately filled even if detected.

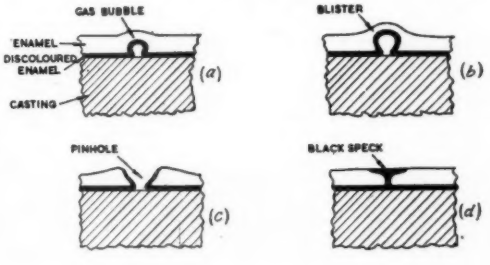
Micro-examination of sections cut through blistered areas of enamelled castings has revealed several types of sub-surface defects. Although the mechanisms of formation of some of these are not fully understood, it does seem fairly obvious that they were in some way connected with the evolution of gas which caused the blisters. Some typical examples are illustrated.

Sample A was taken from a gas-cooker top bar to which a black acid-resisting enamel had been applied after the usual pretreatments of annealing and cleaning. The enamelled casting was free from defects except for one small area of severe boiling. The section thickness of the casting was uniform and the microspecimens were taken through defective and sound areas. The general structure was typical of that of many light castings and consisted of rosette graphite in a matrix of ferrite and a network of phosphide eutectic. In the blistered area, however, the defect illustrated in Fig. 4 was apparent in the casting. There were a number of surface and sub-surface blue-grey inclusions which were apparently cavities which had become filled with oxide. The inclusions were of irregular shape and were in positions normally occupied by the phosphide eutectic network. Where these inclusions were at the surface of the casting there were deep blister craters and, in the illustration, the base of one such crater is shown filled with the plastic mounting material used in specimen preparation. More detailed examination of the defect revealed that some inclusions contained small lakes of phosphide and that all had a dark brown rim which in some cases appeared to be continuous with the enamel.

The origin of this type of defect is not understood. The oxide-filled cavities have an interdendritic appearance, but it does not seem logical that they were formed by liquid shrinkage. The fact that they occured in a localized position may suggest a local sand condition or perhaps something entrapped in the metal entering the mould.

Sample B was a gas-cooker bridge enamelled with an acid-resisting grey mottled enamel after the pretreatments of annealing and cleaning. The sample was free from defects except for a small area of deep blister craters through which the microspecimen was taken. The general structure was similar to that of sample A and in the blistered area there were some examples of the defect illustrated in Fig. 4, but in addition there were some defects of the type shown in Fig. 5. These appeared to be developments of the first type, some

FIG. 3.—*Development of blisters, pinholes and black specks: (a) gas bubble forms in enamel; (b) it forms a blister; (c) it bursts and leaves a crater; (d) the crater heals over but discoloured enamel from near the casting forms a black speck.*



* Paper presented at the Glasgow conference of the Institute of British Foundrymen.

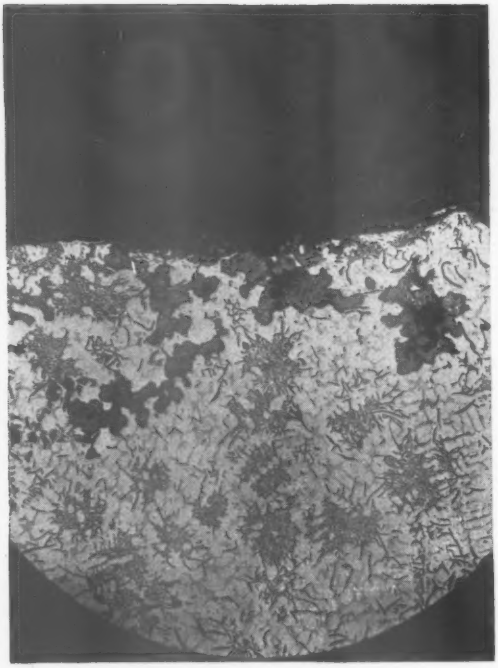


FIG. 4.—*Sub-surface iron-oxide inclusions in sample A which caused severe local blistering; unetched;* ×100.

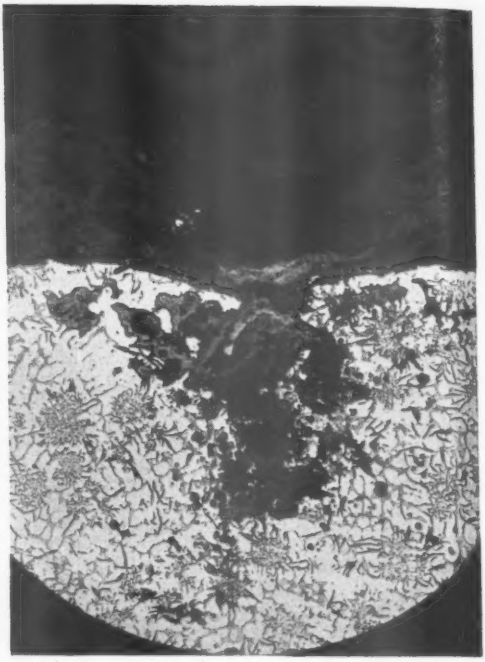


FIG. 5.—*Sub-surface corrosion-type defect in sample B which caused severe local blistering; etched 4 per cent. Picral;* ×100.

of which are also visible in Fig. 5, and may be due to a corrosion effect. It was not known whether this casting had been in store for any length of time prior to enamelling.

The causes of the defects typified in samples A and B are not known, neither is it known to what extent the defects occur in the raw castings and how they are affected by storage, annealing and enamelling. Unfortunately, their localities are only shown up on enamelling, and it would be difficult to detect them in the as-cast condition for examination. Probably the best way to tackle this problem would be to attempt to produce the defect deliberately by varying local mould surface conditions for a test plate casting.

Sample C was the front of a slow-combustion stove to which a soft enamel had been applied after annealing and shot-blasting operations. The sample showed large blister craters fairly evenly distributed over the whole surface. Microspecimens were taken through some blisters and examination showed several oxide inclusions of the type illustrated in Fig. 6. The general structure of the casting exhibited fine flake-graphite clusters in a matrix of ferrite and phosphide eutectic with some pearlite in spheroidized form although there were some examples of primary graphite or "kish" in the structure.

The sub-surface oxide defects appeared to have been in positions originally occupied by primary graphite. Fig. 7, illustrating this point, is a micrograph of the back surface of the same casting and shows an oxide-filled cavity at the surface and two clusters of kish graphite. It is apparent that the oxide inclusion has the same general shape as the kish to which it is linked by graphite flakes. The flakes show increased evidence of oxidation as the casting surface is approached. The layer of oxide on the surface would be removed by shot-blasting but the pockets of oxide just below the surface would remain.

General Blistering:

The three samples described in the previous section illustrated some typical sub-surface defects which were associated with individual blister craters or groups of them. The majority of castings rejected for blistering, however, do not show these defects, and there is no micro-structural evidence to indicate why a blister occurred at its particular location in preference to any other position. Such general blistering can occur over the whole of a casting's surface or it can be associated with thicker sections only or even thinner sections, leaving the other parts blemish free.

It is generally accepted that the gases which cause blistering in vitreous enamels applied to cast

iron are carbon monoxide, carbon dioxide and possibly hydrogen. This, of course, excludes mechanically entrapped gases in sub-surface cavities which have been considered with the subject of blowholes and sand or slag inclusions. Micro-examination of both defective and sound enamelled castings indicates that all enamels contain gas holes and it is merely the size and distribution of these holes which determine whether a component is considered as blistered or sound. Fig. 8 illustrates the microstructure of a sound enamelled casting but the enamel layer contains a considerable number of small spherical holes, confirming that gas was being evolved while the enamel was fluid in the fusing furnace.

Sources of blister gases:

Gases absorbed on the surface of the casting are not usually responsible for blistering, since in the fusing furnace they would be evolved while the enamel is in the porous biscuit stage. It is only those gases which are evolved at higher temperatures which form bubbles in the molten enamel. If the bulk of these gases is evolved while the enamel is in its most fluid state then the blisters will burst at the surface and their craters will heal over to give a good result but if the evolution continues in any quantity while the ware is cooling after fusion the bubbles will be retained as blisters and recently-formed craters will not heal over.

The formation of oxides of carbon requires a source of oxygen available for combination with the carbon of the iron present as graphite or iron carbide. Atmospheric oxygen will combine directly with graphite at elevated temperatures but in the enamelling process this supply is cut off when the enamel fuses and seals the surface of the cast iron. Enamel commences to fuse at temperatures of the order of 500 deg. C. but at this temperature its viscosity is too high for flow to occur in the short time available. Thus, depending on the rate of heating, the enamel coating on a casting becomes continuous and forms a seal from the atmosphere at some temperature above 500 deg. C.

Angus[6] points out that below a critical temperature of about 680 deg. C. oxidation of iron can occur in the presence of free carbon but above this temperature carbon will oxidize in preference to iron. If sufficient oxygen be available the carbon will thus burn out completely above 680 deg. C. and if insufficient free oxygen be available the carbon will reduce the iron oxide.

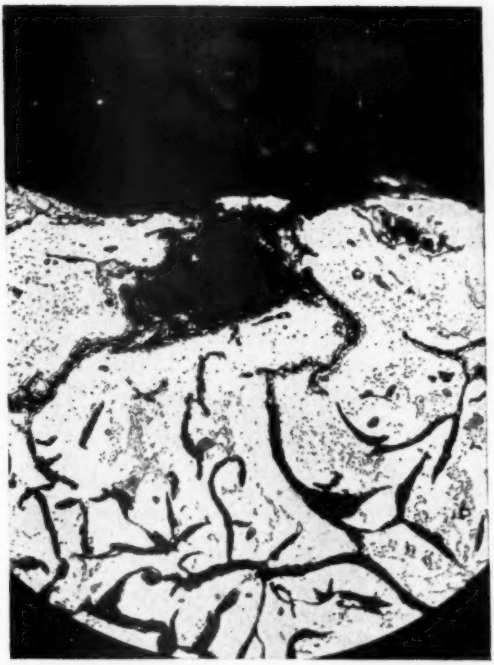


FIG. 6.—*Sub-surface oxide inclusion in sample C which caused blistering; etched 4 per cent. Picral;* × 600.

In the enamelling process, therefore, while the temperature of the ware is rising to that at which the enamel fuses, there will be an evolution of oxides of carbon due to direct oxidation of graphite and at the same time there will be some iron oxide

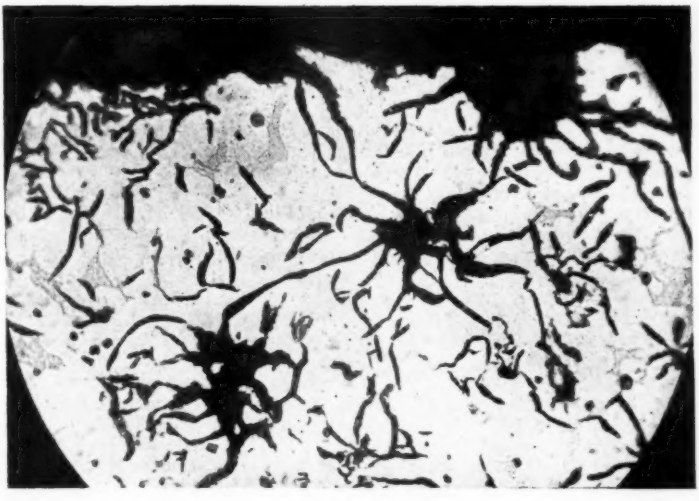


FIG. 7.—*Relation between kish graphite and type of oxide inclusion illustrated in* FIG. 6; *unetched*; × 600.

FIG. 8.—*Microstructure of a sound enamelled casting showing gas bubbles in enamel; etched 4 per cent. Picral;* ×100.

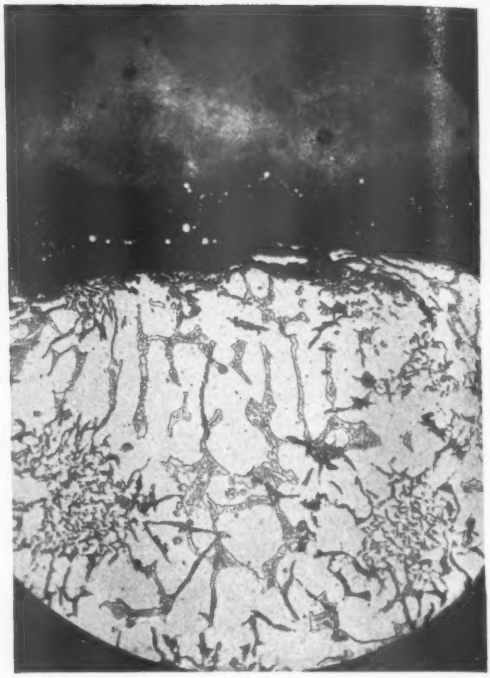


FIG. 9.—*The iron/enamel interface of a sound enamelled casting illustrating metallic particles and needle-like constituent in the enamel adjacent to the casting; etched 4 per cent. Picral;* ×400.

formed. After enamel fusion and up to 680 deg. C. the only oxygen available for oxidation of iron or carbon is that mechanically entrapped in the enamel in what was originally the pore space between individual frit particles. At this stage, therefore, gas evolution will be small and will do little more than replace the pore space originally occupied by atmospheric oxygen. Above 680 deg. C. however, graphite will commence to react with the iron oxide and the reaction will get more vigorous as the temperature increases to the maximum. Bubbling of the enamel will occur but if individual bubbles are small, each crater will heal over as soon as it forms and there is a reasonable possibility that a good result will be obtained. If the bubbles be large, discoloured enamel from near the iron/enamel interface will be brought to the surface to cause black specking and the large craters will take some little time to heal over and those forming later will remain as a blemish on the finished component.

The large oxide inclusions of the types illustrated in Figs. 4, 5 and 6 and described earlier are other sources of oxygen available for reaction with carbon in the enamelling furnace. It has already been shown that these account for severe local eruptions of the enamel.

Hydrogen has been mentioned as a possible blister gas although this element tends to be given off at temperatures below the enamel melting temperature. Moisture is absorbed by castings during storage and rust penetration may occur. Although annealing will convert rust to the less active oxide with the evolution of water, the surface will remain porous and offer a much larger surface area for subsequent absorption of moisture. If rust penetration be severe, it is possible that the enamel becomes fluid before all the rust is decomposed and hydrogen and water vapour become potential blister gases. In any case the oxide remaining after rust decomposition will serve as a highly reactive source of oxygen available for the production of carbon monoxide and carbon dioxide.

Yet another source of oxygen which cannot be overlooked is the enamel itself. Vitreous enamel is a glass of complex composition and structure but most of the types used on iron castings contain oxides easily reducible under certain conditions. It has been shown earlier[4] that antimony oxide is readily reduced in the cupola and metallic antimony passes into solution in the molten iron. There is also evidence to show that a similar reduction also occurs in the enamel fusing process. Fig. 9 illustrating this point shows the microstructure of an iron-enamel interface. The enamel adjacent to the casting contains small metallic inclusions which are probably antimony or some other low-melting-point

metal or alloy. The spherical nature of these inclusions suggests that they were molten at the temperature of the enamelling furnace. It is suggested that the reduction of the metallic oxide occurred by reaction with graphite and the production of oxides of carbon.

APPENDIX

Work on Gas Evolution

MR. EVANS, after presenting the Paper at the meeting, said that, since it had been submitted to the Institute, some work had been carried out on the evolution of gas from cast iron. As it was difficult to control the casting skin for research purposes, the experiments so far had been confined to machined samples. The samples were machined from standard 0.6-in. dia. test-bars and were approximately ⅜-in. dia. and 1¼-in. long. Each specimen was heated to a temperature of 760 deg. C. (a typical enamel fusing temperature) in a tube furnace through which passed a stream of pure, dry argon. This carrier gas was subsequently analysed for the blister-producing gases. A typical graph in which the rate of evolution of carbon monoxide per square inch of specimen was plotted against the time that the specimen was in the furnace was shown in Fig. A. This graph showed that with freshly-machined samples, carbon monoxide was evolved presumably by interaction of carbon and subcutaneous oxide. The evolution commenced after about four minutes—the time at which the specimen attained approximately 650 to 700 deg. C. The specimen attained a temperature of 760 deg. C. after ten minutes and after this the volume of carbon monoxide evolved gradually decreased while the specimen was held at this temperature.

When the specimens had been stored in normal atmosphere for a length of time and then tested, a greater volume of carbon monoxide was observed, as shown in the second part of Fig. A. Also, there was an initial evolution occurring immediately after the introduction of the specimen into the furnace and this might be due to mechanical absorption of gases during storage.

Another interesting factor revealed, was that more gas was evolved from annealed than from as-cast specimens. In the case of the annealed specimens, the heat-treatment was carried out prior to machining. This work had only recently been commenced, and it was hoped that further experiments would throw some light on to the general subject of blistering in cast-iron enamelling.

DISCUSSION

MR. D. MCK. WEBSTER, opening the discussion, said that Scotland took a little credit for having initiated the particular investigation which Mr. Evans had presented. It was the Scottish section of the B.C.I.R.A. light castings sub-committee which had suggested looking into the problems associated with vitreous enamelling—and he used the term "vitreous" as the proper term to cover all enamelling, to include both the "wet" and the "dry" processes. The sub-committee had been very fortunate in having the services of Mr. Evans, who had done valuable work, and members could look forward to obtaining even more interesting results in the future.

As one who had been connected with the industry for many years, Mr. Webster said there had always been, and probably always would be, controversy between the founders and the enamellers, but both sides had made remarkable progress particularly during the last ten or fifteen years. He might be biased because he had started on the enamelling side, but he thought that progress on the enamelling side had outstripped that in the foundry and the object of the investigation was to help foundrymen in producing castings for enamelling. From experience, he urged that if the foundry could improve castings the industry would go a long way to achieving a substantial reduction in the proportion of rejects in the enamelling shop.

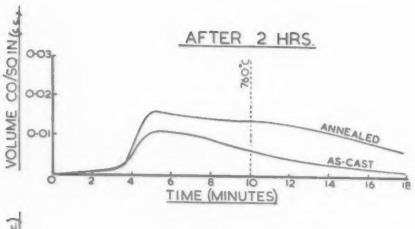
Problems on the enamelling side were no longer a major source of trouble; in a well-run works, rejects due purely to enamelling could be reduced to very low figures; but he felt that the situation was not quite so easy on the foundry side. As enamelling progressed, it had had to contend with more and more mass-production in the moulding shop and he thought sometimes short cuts were taken and castings produced which gave rise to difficulties. On the other hand, castings were produced to-day very much more cheaply than formerly and that aspect should not be lost sight of

Cracking and Warping

MR. F. W. BATES endorsed Mr. Webster's remarks concerning Mr. Evans, who had championed the light-iron castings side. A number of defects which arose in the foundry seemed to be enlarged in the enamelling shop. He had in mind, for example, warping and cracking. Much cracking occurred in the enamelling shop, and often one had difficulty in overcoming it or even in knowing the exact cause. There were sections of varying thickness, of course, but sometimes also in the case of even sections there was a tendency to cracking. He invited Mr. Evans to enlarge on that problem.

"Rat-tailing" and buckling were quite prevalent and were sometimes attributed to the sand used. Mr. Bates suggested that the more common sands in the district, such as the Scottish rotten-rocks sands, had the disadvantage of breaking down rather rapidly. He agreed that there was no golden rule for success, but he would be glad if Mr. Evans would comment on possible methods of control which would overcome the trouble. A stream of metal running over the sand mould heated a section locally, causing a measure of expansion. Was it considered desirable in such cases to widen the ingate to obtain a more even distribution of metal and heat flow, and so prevent localized expansion?

MR. EVANS replied that for cracking to occur, the material must be brittle. The cast iron normally used for light castings was a brittle material, usually containing 1 to 1.4 per cent. phosphorus, and the only way to reduce this inherent brittleness was to reduce the phosphorus content.



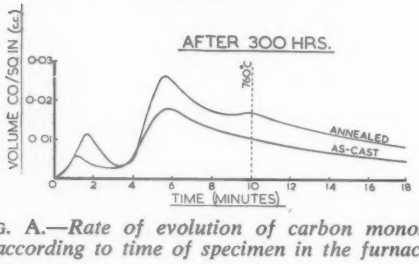


FIG. A.—*Rate of evolution of carbon monoxide according to time of specimen in the furnace.*

In addition, there were other things which could be controlled to a certain extent, and he had mentioned them in the Paper. There were the so-called residual elements, things one did not normally look for in routine analysis, but which could have very serious effects on embrittlement. He mentioned some experiments carried out by the B.C.I.R.A. some time ago which had involved the charging of enamelled scrap into the cupola. It was found that antimony, boron and lead could be absorbed by the metal from enamelled scrap, and it was known that antimony in particular had a very serious effect on the strength of the iron; quite small quantities of antimony, certainly less than 0.1 per cent., could practically halve the tensile strength. Boron was a very strong carbide-stabilizer, and there was evidence that if carbide-stabilizers were present, cast iron tended to be a little more brittle than otherwise. If it was necessary to use enamelled scrap in the cupola, then a small amount should be included in each cupola charge, as serious repercussions would occur in the foundry if, for instance, two or three consecutive charges contained a high proportion of the coated material. Of course, where thicker castings were involved, more of these subversive elements could be tolerated.

"Rat-tailing"

The cure for rat-tailing was not really known, but certain things were known to influence it. By varying the gating method, one could control the flow of the metal into the mould, and if one could not eliminate rat-tails altogether, one could perhaps ensure that they occurred in a part of the casting where they would not show on an assembled product.

If a wide gate were used, then the initial stream of metal would not emerge from its full width at the commencement of pouring and as it was this initial stream which caused rat-tails, the trouble would not be eliminated.

As to the sand properties which influenced rat-tailing, he said it had been shown that the mechanical analysis of the sand had some effect. A sand of fairly uniform grain size was more likely to give rise to rat-tailing than was one which had the grain sizes well distributed through the range.

With a moulding sand of mixed grain sizes, there was, in effect, an "expansion joint" present in the sand which would tend to eliminate buckling. The use of, say, ½ per cent. wood-flour was one way of putting an artificial "expansion joint" into the sand. The toughness of the sand had an effect on rat-tailing, again because of the desirability of having the "expansion joint." It was better to have the sand rammed fairly soft than hard, because then the sand had more room to move. The best measure of the toughness of a sand was probably the shatter index, and in general the higher the shatter the better would be the result from the expansion point of view.

MR. BATES asked if Mr. Evans could suggest a desirable value for shatter index.

MR. EVANS said he would not like to suggest an optimum figure; sand control was not within his sphere of work.

Other Important Factors

MR. J. L. FRANCIS said he had read the Paper with a very great deal of interest, and he joined with previous speakers in thanking Mr. Evans and the B.C.I.R.A. He considered the work described was particularly important, especially having regard to the point raised in the author's "introduction" about the competition which foundries were experiencing and were likely to continue to experience from rival products to replace vitreous-enamelled iron castings.

With regard to the composition of cast iron and ensuring that it was of the most suitable type for vitreous enamelling, nothing was stated in the Paper about the importance of silicon. In the records of much of the previous work on irons which were most suitable for vitreous enamelling, silicon had been mentioned because of its effect on the temperature at which carbon could diffuse and migrate in the solid state. In a pure iron/carbon alloy the critical point was at about 730 deg. C., and that temperature was raised 28 deg. C. for each 1 per cent. silicon, and lowered 25 deg. C. for each 1 per cent. manganese present.

With regard to sub-surface defects in the form of non-metallic inclusions, it was stated in the Paper that the cause and origin of that kind of defect was not known or understood. They were typified in samples A and B (Figs. 4 and 5). Cupola practice and melting technique were not mentioned in the Paper, but they must exert an important influence. For example, the coke could have a high sulphur content, and efficient fluxing was necessary, because nothing could so easily cause scrap in enamelling as the presence of slag in the metal. Particles of entrapped slag were liable subsequently to result in blistering and "boiling" of the enamel. Obviously, the ladle lining must be kept clean and free from "skulls" and slag

build-up, for otherwise these could be a prolific cause of slag inclusions; he had seen shank ladles used in foundries which were in a very bad state of skulling, and with additional slag build-up. That was a very obvious point, but it was surprising how often it was neglected. Highly acid slags were associated with pin-holing of the castings; so also was oxidized melting conditions, which resulted from too low a coke bed.

There was reference in the Paper to the blistering effect of hydrogen derived from moisture and rust during storage. Mr. Francis pointed out that some hydrogen might be dissolved in the casting from the start, and at enamelling temperature it found its way into the graphite cavities, where a reaction might take place, with the formation of gases of the methane type. At the higher "firing" temperatures it might be that hydrogen was released when the carbides passed into solution in the austenite.

Another source of oxygen and hydrogen was water-vapour in the annealing-shop atmosphere and that evolved from the *bisque* in wet-process enamelling during the early stages. That water-vapour affected the outer skin of the casting and formed iron oxide. Again, hydrogen could cause flaking trouble by coming out of solution as the temperature fell; where unfavourable conditions prevailed, the pressure developed might rupture the enamel from the ground-coat.

With reference to cracking, he said Mr. Evans had given the reference to the Paper by Dr. Angus entitled "Cracking in Light Castings." That was a very good Paper, and it might help Mr. Bates if he referred to it again.

MR. EVANS agreed that silicon was an important feature; but, provided the composition was such that the iron was grey and sound, the mere alteration of any particular element within reasonable limits should not affect the "enamelability."

Gases Responsible

MR. H. LONDON said he was very interested in the remarks made on graphite size and distribution and the effect of the atmosphere on blistering in enamel, and asked what Mr. Evans thought about the possibility of annealing the castings in a decarburizing atmosphere prior to enamelling. Would that eliminate much of the blistering trouble?

Finally, he asked for comments on the possibility of hydrogen being the cause of defects. There might be some hydroxyl-ions present which might cause trouble at the enamel/metal interface, where free hydrogen was liberated.

MR. EVANS said it was difficult to comment on the economics of annealing in a reducing atmosphere. With such annealing presumably oxidation would not occur, and there would not be oxide penetration of the graphite flakes. However, there was the possibility that prior to annealing, gaseous oxygen would be absorbed from the atmosphere and that in the annealing furnace some of this oxygen would be available to form the troublesome oxides. Thus, annealing in a reducing atmosphere did not appear to be the answer. If the formation of oxides was the main criterion to be considered, then it would be best to abandon annealing altogether.

With regard to the enamel as a source of hydrogen, he believed that in sheet-iron enamelling that was perhaps the major cause of blistering, but in enamelling of cast-iron the hydrogen liberated from the enamel itself was small at the iron/enamel interface. There was another point, however, namely that the enamel could be a source of oxygen which would combine with carbon. He had already stated that, if enamelled scrap was charged into a cupola, the antimony oxides were reduced; and in the enamelling process they were reduced in the same way. Fig. 9 in the Paper showed that, adjacent to the surface of the cast iron, some metallic material, which presumably was antimony or an alloy of antimony, was deposited in the enamel, and this suggested that reduction had taken place. He suggested that the oxygen evolved during that reduction was available to combine with graphite.

In Defence of Founders

MR. J. BERNSTEIN thought that three non-technical, though vital, factors had been omitted from the Paper, the importance of which could never be over-emphasized: they were *cleanliness, supervision* and *the speed of processing* in the enamelling shop.

There was a tendency for the enamellers to blame the castings and for some foundry people to blame enamels. At that meeting in the heart, and perhaps the birthplace, of the light-iron castings industry hardly a word had been said in favour of castings. Part of the reason for the tendency to turn from cast iron towards steel, especially in the cooker industry, was that the light-castings producers themselves had not taken the trouble to defend their own castings against the onslaught of the enamellers.

MR. EVANS said that he had not intended to put the blame on the castings. The type of cast iron used in the industry consisted essentially of the micro-constituents ferrite, iron-carbide, iron-phosphide and graphite. Air contained oxygen, and as long as oxygen and carbon were in contact at the appropriate temperature they would combine. He did not intend to blame castings for one of their fundamental properties, but he suggested that a further investigation was necessary to find out how gas evolution could be controlled. It must be accepted that gas would be evolved at some stage in the enamelling process, and a so-called blister-free enamelled casting was only produced when either the gas evolution had ceased at the maximum temperature in the fusing furnace, or the gas bubbles were too small to be offensive to the eye on the finished component.

The CHAIRMAN (Mr. H. J. V. Williams), in thanking and congratulating Mr. Evans, said his Paper afforded a fine example of how the B.C.I.R.A. was co-operating with a section of the industry, an example to some members and sections of the industry who were not making full use of the Association.

Personal

DIPL. ING. PHILIPP SCHNEIDER has been appointed Editor of *Giesserei*, the German magazine devoted to foundry practice.

EDGAR ALLEN & COMPANY, LIMITED, announce the appointment of Mr. George H. Marsden as technical representative for their steel foundry department.

DR. E. H. SONDHEIMER, Lecturer in Mathematics at the Imperial College of Science and Technology, London, has been appointed to the university Readership in Applied Mathematics tenable at Queen Mary College.

MR. F. J. WHITE has been elected president of the Purchasing Officers' Association. He is chief buyer to Chance Brothers, Limited. The national chairman is MR. R. J. MITCHELL, of the Morgan Crucible Company, Limited.

MR. BROOKS MCCORMICK, who has been managing director of the International Harvester Company of Great Britain, Limited, for the past two years, has been appointed director of manufacturing of the International Harvester Company, Chicago.

MR. A. C. FURSE-ROBERTS has been appointed secretary of the A.P.V. Company, Limited, dairy and brewery engineers, etc., of London, S.W.18, in succession to Mr. H. C. BAIGENT, who has resigned after holding the position for nearly 32 years. He will continue, however, as a full-time executive in the capacity of financial director.

MR. L. R. ROBERTS, who held the position of sales manager at George Fletcher and Company, Limited, ironfounders and general engineers, of Litchurch Lane, Derby, has retired after 50 years' service with the firm. As a memento of the occasion he was presented with a cheque on behalf of the directors, by Mr. C. W. Murry, managing director. From the employees he received the gift of a grandfather clock, which was presented by Mr. J. W. St. John Smith, assistant drawing office manager.

Obituary

MR. ARTHUR PHILIP COOTE, a director of the Butterley Company, Limited, Ripley, and a former estate manager of the company, died on October 5, aged 67.

MR. GEORGE RAWCLIFFE, a director and manager of the Colne firm of John Pilling & Sons, Primet Foundry, died on October 4, aged 69. He had been with the firm since 1922.

Until his retirement in 1932, MR. WILLIAM TAWSE, of Braemar, Scotland, who died on October 5, was for many years chief chartered accountant of Harland & Wolff, Limited. He was 83.

MR. FRANK B. CASSIE, managing director of George Cassie & Son, Limited, makers of materials-handling equipment, of Aberdeen, died on September 29 at the age of 69. He succeeded his father in the control of the company in 1921.

Air Chief-Marshal Sir RODERIC HILL, Rector of the Imperial College of Science and Technology, died suddenly last week at the age of 60. Sir Roderic who was elected Vice-Chancellor of the University of London in 1953 and re-elected for 1954-55, had a distinguished career as a scentific air officer in the R.A.F., extending over 32 years until his retirement in 1948.

Board Changes

MUREX, LIMITED—Lt.-Col. J. F. Todhunter has resigned from the Board.

BUTTERLEY COMPANY, LIMITED—Mr. R. W. F. Wilberforce has been appointed a director.

STURTEVANT ENGINEERING COMPANY, LIMITED—Mr. M. F. Stevens has retired from the Board.

STAVELEY COAL AND IRON COMPANY, LIMITED—Mr. Fred Archdale and Mr. Will Archdale have been elected to the Board.

W. T. FLATHER, LIMITED—Mr. John Edmonds, secretary, has been appointed local administrative director with a seat on the Board.

R. B. PULLIN & COMPANY, LIMITED—Mr. N. H. M. Steinbock and Mr. H. M. Whitcombe have been appointed additional directors.

W. H. DORMAN AND COMPANY, LIMITED—Mr. W. E. Mitchell and Mr. J. W. Whimpenny, previously special directors, have been elected to the Board.

DAVEY PAXMAN & COMPANY, LIMITED—Mr. L. L. Bott, works manager; Mr. A. G. Howe, chief engineer and Mr. T. L. Kendall, sales director of Ruston & Hornsby, the parent company, have been elected directors.

KODAK, LIMITED—Mr. E. E. Blake has resigned as chairman of the Board in order to have more leisure. At their request, Mr. Blake will continue as a director of the company and particularly will act as adviser on motion-picture matters.

PEGLERS, LIMITED—Mr. A. E. Emberton has retired as managing director but remains chairman of the company. Mr. Charles Malcolm Smith has retired as assistant managing director, but remains vice-chairman. Mr. Arthur Herbert Smith has been appointed managing director.

UNITED GAS INDUSTRIES, LIMITED—Following the acquisition of the share capital of Dowson & Mason Gas Plant Company, Limited, engineers, gas plant and furnace specialists of Levenshulme, Manchester, the Board of Dowson & Mason Gas Plant Company, Limited, has been reconstituted with Mr. P. P. MacDiarmid, a director of United Gas Industries, Limited, as chairman. Mr. H. G. Wrigglesworth, the group financial controller of United Gas Industries, Limited, has been elected to the Board of Dowson & Mason, and Mr. L. G. A. Leonard is to continue as director and general manager.

Sheffield's 319th Master Cutler

"The export trade of Sheffield industries generally has been satisfactory lately," said Sheffield's 319th Master Cutler, Mr. W. G. Ibberson, at his installation on October 5. He went on, "It seems likely to remain so, except to those countries where currency problems still plague us, or bilateral agreements operate adversely against us." Mr. Ibberson stated that everywhere he heard of new ideas being developed and large contracts worth many millions for capital equipment had been obtained recently in spite of world competition. They ensured work for several years. The new Master Cutler criticized the increases in fuel costs by the nationalized industries, especially gas, as well as wastage of fuel in industry.

After his installation, he entertained 120 employees from his firm, George Ibberson and Company, Limited, and the Skinner Tool Manufacturing Company, Limited, Broad Lane, of which Mr. Ibberson is chairman, to luncheon on October 6.

SHELL MOULDING QUERIES
No. 5

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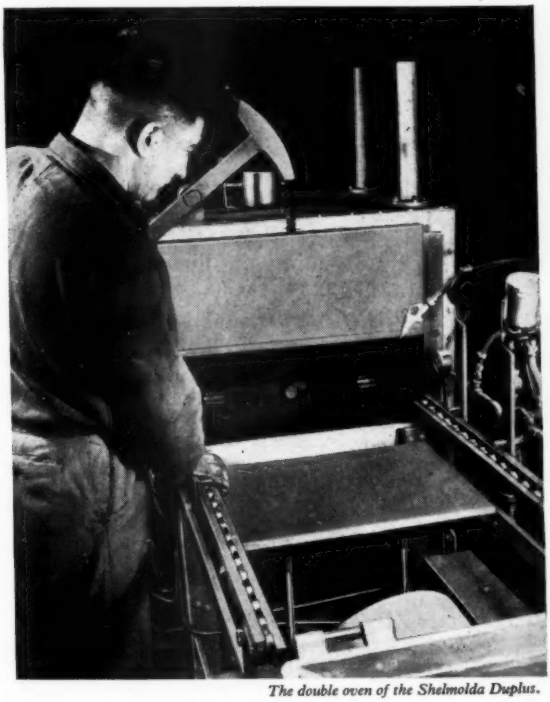

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News in Brief

AT THE 8th International Scientific Film Congress to be held in Rome, from December 6-12, the British Cast Iron Research Association is exhibiting a film.

SLOUGH METALS, LIMITED, Oxford Avenue, Trading Estate, Slough, have appointed Mr. J. A. Sparks as their sales agent for east and south east England.

ACCORDING to reports, the Canadian International Trade Fair at Toronto was eminently successful. The next one is to be held from May 30 to June 10, 1955.

SECOND SAFETY and Factory Efficiency Exhibition is to be held in Bingley Hall, Birmingham, from June 24 to July 1, 1955. In 1953, the exhibition was visited by 19,000.

MR. A. R. W. LOW, Minister of State, Board of Trade, is to be the principal speaker at the Institute of Directors' dinner at the Grand Hotel, Birmingham, on October 15.

A NEW 1,000-watt mercury high-bay industrial lighting unit has been developed and placed on the market by Holophane, Limited, Elverton Street, London, S.W.1, for use in foundries, heavy-engineering shops, and the like.

MR. A. B. S. YOUNG, managing director of Mechans, Limited, engineers, Glasgow, last week presented long-service certificates with sums of money to 135 employees whose working years with the firm totalled 4,000.

THE INTERNATIONAL Nickel Company of Canada, Limited, have, as a result of extensive research, developed the production of electrolytic cobalt, which as a high purity metal will be valuable to manufacturers of alloys incorporating this element.

DOWDING & MILLS, LIMITED, Birmingham, announce that Mr. Peter Hollings, who was formerly assistant to the general manager at the main Birmingham works will take over duties as London manager at the works at 24 White Post Lane, Hackney, E.9.

COURT WORKS, LIMITED, W. G. Bagnall, Limited, Heenan & Froude, Limited, Fielding & Platt, Limited, members of the Heenan & Froude group of companies are exhibiting at the British Trade Fair in Baghdad to be held from October 25 to November 8.

A TOTAL of 208 years' service with Henry Wiggin & Company Limited, the Birmingham nickel alloys firm, is the impressive record of the Robinson family of Ladywood, five members of which are still keeping up the family tradition of association with the firm.

"THE BIRTH OF STEEL" is the title of a masque to be presented by students of Sheffield University before the Queen when she visits the city on October 27. It is an allegory combining figures of classical mythology and choruses of steelworkers. The cast of 60 will perform before the Queen and the Duke of Edinburgh in the University quadrangle.

INDUSTRY needs "the whole man with a decently based judgment as well as a number of skills," the Rev. R. G. Lunt, chief master of King Edward's School, Birmingham, told members of the Birmingham Junior Chamber of Commerce on October 5. He was discussing education in relation to industry, and said that vocational guidance was not necessarily good.

EIGHTEEN EMPLOYEES of Hadfields Limited, Sheffield, were presented with an electric clock each, at the East Hecla works, to mark their 25 years' service with the company. There are now 1,244 members of the firm's "25" Association, including nine women. The presentations were made on October 4 by Mr. Harold Humphries, managing director.

THE NORTH BRITISH STEEL FOUNDRY, LIMITED, steel-founders and engineers, Balbardie Steel Works, Bathgate, announce that Mr. L. P. Cleminson, M.A., A.C.A., has been appointed secretary to the company and will take up office on November 1 next. Mr. E. W. Clark has been appointed chief accountant to the company, also with effect from November 1.

THE ROOTES GROUP, through the Bradford motor engineering firm of Thornton Engineering Company, Limited, has presented to the Bradford Technical College, for the motor-vehicle section of the engineering department, a 27 h.p. Humber petrol engine, exactly the same type as that which was fitted to Lord Montgomery's car during the desert campaign in the last war.

THE STANTON IRONWORKS COMPANY, LIMITED, are exhibiting at the Public Works and Municipal Services Exhibition, Olympia, from November 15 to 20, a range of spun-iron pipes of 3-in. to 27-in. dia., special castings, and flexible joints, for gas, water, and sewage mains. Spun-concrete pipes will also be on view, together with samples of dry and treated blast-furnace slag, machine cast and refined pig-iron will be shown.

A LIST of Sheepbridge exhibits at the Commercial Motor Transport Exhibition (September 24 to October 2) and Motor Show (to be held at Earls Court October 20 to 30) includes dry and wet-type cylinder liners in the Centricast range of alloy cast-irons; camshafts and crankshafts, sand- and shell-moulded iron castings; individually-cast piston rings; aluminium pistons; valve-seat inserts and die-cast iron and bronze rod for bushes, gear blanks, etc.

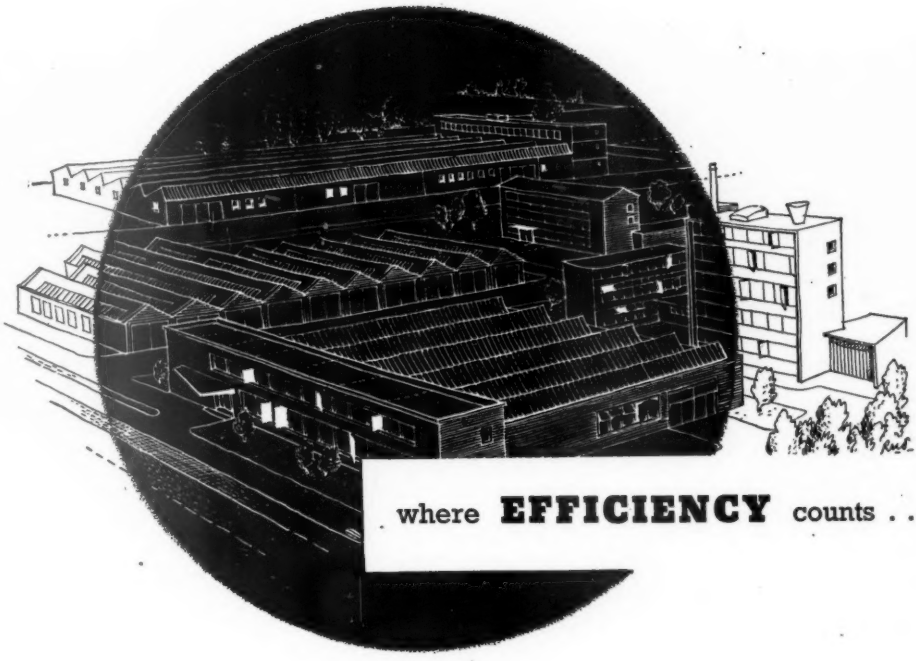
AT DUDLEY TOWN HALL on October 12, the directors of Lee, Howl and Company, Limited, Tipton, celebrated the 70th birthday of their chairman, Mr. Clifford Howl, with a dinner in his honour. Mr. Howl joined the family business about 1907. In his wide professional experience, Mr. Howl has been a member of the council of the Engineering and Allied Employers' Federation and also of the council of the British Cast Iron Research Association.

DEMAND FOR LABOUR in Bilston, where the foundry industries are short of personnel, is appreciably in excess of the available supply, Mr. D. W. Howell, secretary, told the quarterly meeting of Bilston Employment Committee. There was no known short-time working, he said, and many firms were regularly working overtime. The unemployed register totalled 92 on September 20 but 16 of the 44 wholly unemployed were disabled.

A SHORTAGE of experienced women in the small tool and cutlery industries in Sheffield is being overcome by improvised training for new entrants, many of whom are in the older age groups. The quarterly report of the Sheffield and District Employment Committee, states that the growing shortages of workers for nearly every industry in Sheffield have led to a better deal for the higher age groups. But there is still some short-time working in the steel and file trades.

THE EAST AND WEST RIDINGS DIVISION of the Federation of British Industries held their annual meeting at the Royal Victoria Hotel, Sheffield, on October 7, when they were addressed by Sir Harry Pilkington, president of the Federation of British Industries. Sir Harry criticized the "danger inherent in the system of the Monopolies and Restrictive Practices Commission," and said its workings, as governed by the Monopolies Act, were leading to an increased feeling of injustice and bitterness.

(*Continued on page* 462)



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News in Brief

(*Continued from page* 460)

MR. MICHAEL HOPE, chairman and joint managing director of Henry Hope & Sons, Limited, Smethwick, said on October 4 that unless industrialists realized that "things had to look nice as well as work well" Britain would begin to lose markets to countries which paid more attention to this point, when he spoke at the Wolverhampton College of Art's Diploma Day. Mr. Hope has recently been appointed by the Board of Trade to the governing council of the Council of Industrial Design.

THE METALLURGICAL LABORATORIES of the British Welding Research Association are holding "Open Days" on November 23 and 24 at 29, Park Crescent, London, W.1. Researches on both ferrous and non-ferrous alloys will be displayed covering many welding processes including the argon-arc, metal-arc and self-adjusting-arc processes. Admission will be by ticket only and persons who wish to attend should write to the secretary, British Welding Research Association, at the address quoted above.

"OPEN HOUSE" was organized on Saturday, October 9, at the Luton works of Hayward Tyler & Company, Limited. Offices, foundries, machine and assembly shops were inspected by employees, their families and friends. Each visitor was given a mimeographed booklet giving the route, programme of events, details of cinema shows, times of casting up, etc., as well as a brief history of the works—which was founded in 1815. The whole organization was very thoroughly carried out and "Open House" proved a very popular function.

THE THIRD SESSION of the interim committee of the International Tin Council met in London on September 20-21. The countries which have signed the International Tin Agreement but which are not members of the interim committee had been invited to the meeting. There were present delegates from Australia, Belgian Congo, Belgium, Bolivia, the British Colonial and Dependent Territories, Canada, Denmark, France, India, Indonesia, Italy, Japan, Lebanon, the Netherlands, Spain, Thailand, Turkey and the United Kingdom.

THE BRITISH TRANSPORT COMMISSION announce that as a further step in their programme for the development of multiple-unit lightweight Diesel passenger trains, a contract has been placed with British United Traction, Limited, of London, for 43 sets of power equipment and 21 sets of trailer-car equipment. Each power car will embody two 150 h.p. Diesel engines with mechanical transmission. The cars for which these power equipments are intended will be designed and built at the Swindon Works of British Railways.

IF THE WALSALL firm of Castings, Limited, can convince Aldridge Planning Committee that its processes will not create smoke, dust or noise, it hopes to build at Aldridge one of the most up-to-date malleable iron foundries in the country. The firm has applied for a seven-acre site and at its last meeting Aldridge Urban Council approved a resolution that the application be granted, subject to evidence that no nuisance would be caused. Castings, Limited, was founded in 1835. The initial cost of the new foundry is expected to be about £100,000, and it is proposed to put down plant to cover about four acres.

WILMOT BREEDEN, LIMITED, Birmingham, are purchasing a 3½-acre factory at Bridgwater, Somerset, it was announced on October 1. It is stated that the acquisition of the new premises will relieve pressure on the expanding motor-component side of the firm's production. Built in 1938, the Bridgwater works originally belonged to Trojan, Limited. It has recently been vacated by Hardy Spicer and Company, Limited, one of the Birfield Industries Group. It will be recalled that last month Wilmot Breeden announced proposals to increase capital. Sir Harold Roxbee Cox, an expert on gas turbines and jet engines recently joined the Board.

GERMAN COMPETITION was something the British motor industry had to watch but should certainly not create a panic, Mr. J. F. Bramley, managing director of the Austin Motor Export Corporation, Limited, told Birmingham Rotary Club on October 4. Too much had been said about German resurgence in the motor car industry, he said, and the impression might have been created in some minds that it was undermining the industry in Britain. "The fact is that Germany is at present producing no more than 60 per cent. of our total output and only 40 per cent. of our output for export," he said. "We should not be afraid of Germany knocking us out of world markets."

TO MEET the heavy demands made on the "flexible" advisory service of Compoflex Company, Limited, by industry in the Midlands and north of England, the company has opened a Northern Flexible Centre at their factory in Huddersfield Road, Oldham. The centre, which was officially opened on October 6 by Mr. Ian Horobin, M.A., M.P., is staffed by a team of specialists able to give advice on the most suitable flexible tube or hose to use in any given situation. A development section has also been started in Oldham, to deal with the design of special flexibles for particular projects. The first Flexible Centre was opened by Compoflex Company, Limited, at their head office at 26 Grosvenor Gardens, London, W.1, in 1952.

AN ARTIFICIAL "JUNGLE" is on show at the exhibition of electrically-heated industrial equipment in the Midlands Electricity Board's industrial showroom at Aston. The exhibit reproduces tropical weather conditions so that goods can be tested for their resistance to varying humidities, proving especially useful to exporters. The exhibition which is staged by the Board in conjunction with Barlow-Whitney Engineering Limited remains open until October 15. A variety of furnaces shown includes one that can produce a temperature of 1,400 deg. C., and another that is no larger than a large book. There is also a two-ton piece of equipment for vacuum impregnating electronic components and giving thm a finish that will withstand damp tropical conditions.

AT THE ELEVENTH annual long-service presentations of the Birmid group of industries at Smethwick on Saturday, September 25, employees who had been with the firm for 25 years and over received illuminated certificates and chiming clocks. There were 94 recipients, but 29 of them received their awards at functions at other branches of the group. "The number of awards this year is a record," said Mr. E. Player, managing director of the group in his opening speech, "This year's number brings our total up to the imposing figure of 986." Presenting the awards was Mr. Alan Graham, managing director of Perry Barr Metals, Limited. A special award of a gold watch went to a 76 year-old moulder, Mr. Spittle, of West Bromwich, who has served with the firm for 45 years, and is one of their oldest moulders. He said that one reason he is still "going strong" is that up-to-date machinery in the foundry has made working conditions a lot easier than they were 20 years ago. The only woman recipient was Miss Doris Simkin. Before and after the presentations, the recipients, their wives and friends, enjoyed a variety show.

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Raw Material Markets

Iron and Steel

Changes in the pig-iron trade amount to no more than the merest nuances. Scarcity of low- and medium-phosphorus iron has given an impetus to trade in hematite and some grades of refined iron. There are minor fluctuations in the flow of specifications for common foundry iron. But the overall position is sound. Blastfurnacemen are well provided with coke, ore, and limestone and are readily disposing of their outputs. Supply, in fact, has not yet fully overtaken the demand and the completion of new blast furnaces now in course of construction is eagerly anticipated as a means of providing the additional tonnages of basic iron which are clearly needed to meet the full requirements of the steel plants. Meanwhile, pig-iron is still being imported from the Continent and withdrawals from stock are not infrequent.

The spectacular expansion of steel production has almost completely emancipated the re-rolling industry from its traditional dependence upon a steady flow of cheap semi-finished steel products of foreign manufacture. Imports have fallen to a very low ebb. But difficulties have recently developed in providing the increased tonnages of billets, sheet bars, slabs, etc., which are now required for the re-rolling mills, and it may become necessary as a temporary measure to seek additional supplies from the Continent. In the meantime, there is a brisk demand not only for prime billets, but also for defectives and re-rolling scrap. Wire mills are desperately in need of wire rods and sheetmakers are calling for maximum tonnages of bars and slabs.

Ingot production was never greater than it is to-day and there is scarcely a rolling mill in the country which is not operating to the limit of its capacity. Moreover, maximum tonnages are being cleared from the loading barges. Yet still there seems to be a large unsatisfied demand and buyers are eager to place orders for finished steel products even for remote delivery dates. Export quotas, of course, do not extend beyond the expiry of 1954, but there are no such limitations on home trade and a good many orders have been booked which will not receive attention until after the turn of the year. Works have an immense accumulation of orders for plates, heavy sections, and sheets, while bookings for re-rolled bars and sections have recently been accruing in excess of current output.

Non-ferrous Metals

The unprecedented upsurge in the copper price culminated last week when at £310 for cash the market boiled over and fell back to £290, before a recovery swung the quotation up to £300 again. The week ended with cash £5 up on balance and three months £1 higher, the backwardation standing at £20. In the United States, 30 cents remains nominally the domestic figure, but the export f.a.s. price is around 35 to 36 cents. The situation is confused and clarification waits on some announcement by the Banco de Chile as to what its selling level will be. Opinion differs on whether the American producers can hold their price at 30 cents, which is unreal in the light of developments. Their obvious reluctance to make a move upwards is due, presumably, to the fact that if that happens new wages negotiations must be opened.

Meanwhile, the strikes at the Utah refinery and Garfield smelter continue, following a breakdown in the talks for a settlement, and it is not surprising that Washington has decided on withholding export licences after October shipments have run their course. A continuance of a high price for copper is indicated for several months, for the loss of copper due to strikes is estimated so far at not less than 100,000 tons. The vagaries of the copper market have made it necessary to make frequent changes in the prices of both brass and copper semis.

The dock strike in London has held up incoming cargoes of copper and lead, the latter, consequently, being particularly strong. First half October rose by £4 5s. and first half January by £2 2s. 6d., the backwardation at the end of the week being £5 10s. In the States the quotation went up by 25 points to 15 cents, which is equal to about £120. Zinc firmed up again and gained £2 5s. on the week's trading. No change was seen in the U.S. price at 11½ cents, but it is talked higher, even, perhaps, to 12 cents. Tin was steady and higher at £737 for cash and £735 10s. three months, these figures showing gains of £6 and £4 10s. for the respective positions. The scrap market is considerably disorganized owing to the rapid changes in copper.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* October 7, £285 to £290; October 8, £295 to £300; October 11, £290 to £292 10s.; October 12, £280 to £282 10s.; October 13, £277 to £280.

Three Months: October 7, £268 to £270; October 8, £279 to £280; October 11, £276 to £277; October 12, £264 10s. to £265; October 13, £262 to £263.

TIN, Standard—*Cash:* October 7, £734 to £735; October 8, £736 10s. to £737; October 11, £737 to £737 10s.; October 12, £732 to £732 10s.; October 13, £734 10s. to £735.

Three Months: October 7, £733 10s. to £734; October 8, £735 10s. to £736; October 11, £735 10s. to £736 10s.; October 12, £732 to £732 10s.; October 13, £734 to £734 10s.

ZINC—*First half October:* October 7, £83 to £83 5s.; October 8, £83 10s. to £83 15s.; October 11, £84 to £84 5s.; October 12, £83 10s. to £83 15s.; October 13, £83 10s. to £84.

First half January: October 7, £82 15s. to £83; October 8, £83 10s. to £83 15s.; October 11, £84 to £84 5s.; October 12, £83 10s. to £83 15s.; October 13, £83 10s. to £83 15s.

LEAD—*First half October:* October 7, £110 to £110 15s.; October 8, £110 10s. to £111; October 11, £109 to £109 10s.; October 12, £107 to £107 10s.; October 13, £108 to £109.

First half January: October 7, £104 15s. to £105; October 8, £105 to £105 10s.; October 11, £104 10s. to £104 15s.; October 12, £103 to £103 5s.; October 13, £103 5s. to £103 15s.

Recent Wills

BATLEY, W. A., lecturer in fuel technology at Sheffield University £5,872

MÅKEMSON, TOM, secretary of the Institute of British Foundrymen £12,900

TIMSON, A. R., founder and chairman of Timsons, Limited, machinery manufacturers and ironfounders, of Kettering £35,819

JONES, GEORGE, joint managing director of William Jones & Sons, Limited, ironfounders and hardware manufacturers, of Birmingham £5,222

PECHAL, FRANK, late of Fry's Diecastings, Limited, Merton Abbey, London, S.W.19, and Stone-Fry Magnesium, Limited, Merton Abbey £14,273

HICKLING, PROF. H. G. A., Professor of Geology at Kings College, Newcastle-upon-Tyne, 1920-48, and former president of the Geology Section of the British Association £5,453

FRANCE, JAMES, of Linthwaite, near Huddersfield, retired ironfounder and haulage contractor, at one time national president of the Commercial Motor Users' Association of Great Britain ... £13,130

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It is well known that the hardness of ordinary cast iron depends to a large degree on the Silicon content of the metal. Silicon acts as a softening agent in cast iron by its action in reducing the amount of combined carbon, which is liberated in the form of free graphite. The presence of free graphite and a low combined carbon content contribute towards easy machineability.

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Current Prices of Iron, Steel, and Non-ferrous Metals

(*Delivered unless otherwise stated*)

October 13, 1954

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £14 19s. 6d.; Birmingham, £14 12s. 9d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 5s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £17 16s. 9d.

Scotch Iron.—No. 3 foundry, £17 9s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 19s. 6d.; South Zone, £19 2s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 19s. 6d.; South Zone, £20 2s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £17 14s. 6d.; Scotland (Scotch iron), £18 1s. 0d.; Sheffield, £18 19s. 0d.; Birmingham, £19 6s. 6d.; Wales (Welsh iron), £18 1s. 0d.

Basic Pig-iron.—£15 10s. 6d. all districts.

FERRO-ALLOYS

(*Per ton unless otherwise stated, delivered*)

Ferro-silicon (6-ton lots).—40/55 per cent., £42 0s. 0d., basis 45 per cent. Si, scale 17s. per unit; 70/84 per cent., £65 0s. 0d., basis 75 per cent. Si, scale 18s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £185 9s. 0d. to £195 0s. 0d. per ton; 38/40 per cent., £251 0s. 0d. to £270 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 13s. 4d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 16s. 4d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £75 0s. 0d. to £80 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £74 0s. 0d. to £76 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 7½d. per lb. Cr; 1 per cent. C,* 1s. 8d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. per lb. Cr; 0.10 per cent. C,* 1s. 9¾d. per lb. Cr; 0.06 per cent. C,* 1s. 10d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 6½d. to 7s. 1d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £54 15s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £225 12s. 6d.; tested, 0.08 to 0.25 per cent. C, £226 12s. 6d.; hard (0.41 to 0.60 per cent. C), £28 0s. 0d.; silico-manganese, £33 16s. 0d.; free-cutting, £28 16s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 12s. 0d.; silico-manganese, £34 17s. 6d.

* Average 68-70 per cent. Cr.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 0s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £32 9s. 0d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £32 7s. 0d.; flats, 5 in. wide and under, £32 7s. 0d.; hoop and strip, £33 9s. 0d.; black sheets, 17/20 g., £42 1s. 0d.; galvanized corrugated sheets, 24 g., £51 8s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £53 8s. 0d.; nickel-chrome, £75 2s. 0d.; nickel-chrome-molybdenum, £84 13s. 6d.

NON-FERROUS METALS

Copper.—Cash, £277 10s. 0d. to £280 0s. 0d.; three months, £262 0s. 0d. to £263 0s. 0d.; settlement, £280 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 34½d. per lb.; wire, 335s. 9d. per cwt. basis; 20 s.w.g., 367s. 0d. per cwt.

Tin.—Cash, £734 10s. 0d. to £735 0s. 0d.; three months, £734 0s. 0d. to £734 10s. 0d.; settlement, £735 0s. 0d.

Zinc.—First half October, £83 10s. 0d. to £84 0s. 0d. first half January, £83 10s. 0d. to £83 15s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £114 10s. 0d.; rolled zinc (boiler plates), all English destinations, £112 5s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £96 0s. 0d.

Lead (Refined Pig).—First half October, £108 0s. 0d. to £109 0s. 0d.; first half January, £103 5s. 0d. to £103 15s.

Brass Tubes, etc.—Solid-drawn tubes, 27⅝d. per lb.; rods, drawn, 36⅛d.; sheets to 10 w.g., 300s. 3d. per cwt.; wire, 34⅝d.; rolled metal, 286s. 6d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £197; B6 (85/15), £245; BS249, £204.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £220; HTB2 (38 tons), £230; HTB3 (48 tons), £240.

Gunmetal.—RCH, 3/4 per cent. tin, — ; BS1400, LG2 (85/5/5/5), £242 ; LG3 (86/7/5/2), £253 ; G1 (88/10/2/⅛), £322; (88/10/2/1), £312.

Phosphor Bronze.—BS1400, PB1 (AID released), £335 per ton.

Phosphor Bronze Strip, etc.—Strip, 424s. 0d. per cwt.; sheets to 10 w.g., 446s. 6d. per cwt.; wire, 52⅜d. per lb.; rods, 45½d.; tubes, 44d.; chill cast bars: solids 44d., cored 45d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 6d. per lb.; round wire, 10g. in coils (10 per cent.), 3s. 10½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 3s. 10½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £105 0s. 0d. Nickel, £483 0s. 0d. Aluminium, ingots, £156 0s. 0d.; aluminium bronze (BS1400), AB1, £280 ; AB2, £2 0. Solder, brazing, BS1845, 2s. 3d. lb.; granulated, 2s. 6d. lb.